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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY
WITH INDEXES
Supplement 73

AUGUST 1976

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 73

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in July 1976 in

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 206 reports, journal articles, and other documents originally announced in July 1976 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

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TYPICAL CITATION AND ABSTRACT FROM STAR

NASA SPONSORED DOCUMENT	N76-11046 #	Georgia Inst of Tech, Atlanta	AVAILABLE ON MICROFICHE
NASA ACCESSION NUMBER	STUDY OF VISCOUS FLOW ABOUT AIRFOILS BY THE INTEGRO-DIFFERENTIAL METHOD Final Report		CORPORATE SOURCE
TITLE	James C Wu and Sarangan Sampath Oct 1975 61 p refs (Grant NsG-1004)		PUBLICATION DATE
AUTHORS	(NASA-CR-145693) Avail NTIS HC \$4 50 CSCL 01A		AVAILABILITY SOURCE
CONTRACT OR GRANT	An integro-differential method was used for numerically solving unsteady incompressible viscous flow problems. A computer program was prepared to solve the problem of an impulsively started 9% thick symmetric Joukowski airfoil at an angle of attack of 15 deg and a Reynolds number of 1000. Some of the results obtained for this problem were discussed and compared with related work completed previously. Two numerical procedures were used: an Alternating Direction Implicit (ADI) method and a Successive Line Relaxation (SLR) method. Generally, the ADI solution agrees well with the SLR solution and with previous results at stations away from the trailing edge. At the trailing edge station, the ADI solution differs substantially from previous results, while the vorticity profiles obtained from the SLR method there are in good qualitative agreement with previous results.	YJA	COSATI CODE
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TYPICAL CITATION AND ABSTRACT FROM /AA

NASA SPONSORED	A76-10264 #	Hybrid upper surface blown flap propulsive-lift concept for the Quiet Short-Haul Research Aircraft	AVAILABLE ON MICROFICHE
AIAA ACCESSION NUMBER	J A Cochrane and R J Carros (NASA, Ames Research Center, Moffett Field, Calif)		AUTHORS
TITLE	<i>American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 11th, Anaheim, Calif, Sept 29-Oct 1, 1975, AIAA Paper 75-1220</i>		AUTHORS' AFFILIATION
MEETING DATE	9 p 5 refs		NAME OF MEETING
	<p>The hybrid upper surface blowing concept consists of wing-mounted turbofan engines with a major portion of the fan exhaust directed over the wing upper surface to provide high levels of propulsive lift, but with a portion of the fan airflow directed over selected portions of the airframe to provide boundary layer control. NASA sponsored preliminary design studies identified the hybrid upper surface blowing concept as the best propulsive lift concept to be applied to the Quiet Short-Haul Research Aircraft (QSRA) that is planned as a flight facility to conduct flight research at low noise levels, high approach lift coefficients, and steep approaches. Data from NASA in-house and NASA-sponsored small and large-scale wind tunnel tests of various configurations using this concept are presented.</p> <p>(Author)</p>		

AERONAUTICAL ENGINEERING

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IAA ENTRIES

A76-28785 **Differential-turn maneuvering** H J. Kelley
(Analytical Mechanics Associates, Inc., Jericho, N Y) In International Federation of Automatic Control, Triennial World Congress, 6th, Boston and Cambridge, Mass., August 24-30, 1975, Proceedings Part 1. Pittsburgh, Pa., Instrument Society of America, 1975, p 23.3 1-23 3 4 10 refs

Control harmonization for flight controls which are additional to the conventional ones, such as thrust-vectoring and variable-sweep controls, is examined by means of a hodograph device for the case of flight of a single aircraft under manual control, in one version, or optimal control in another. The use of thrust vectoring in a turning duel formulated as a differential game with energy-modeled vehicles is examined in a preliminary qualitative way. For a craft with sufficient thrust to provide hovering capability, the resulting high turn rates attainable at very low energies greatly enhance evasive capability but do not lend themselves well to offensive exploitation with short-range tail-aspect armament (Author)

A76-28920 **Simulated aircraft disaster instructional exercise at Baltimore-Washington International Airport** D Evans
(Friendship International Airport, Md) *Aviation, Space, and Environmental Medicine*, vol 47, Apr 1976, p 445-448

A major, simulated aircraft disaster exercise was held in September of 1974 at the Baltimore Washington International Airport in Maryland. The significant aspects of community involvement and specialized airport emergency planning were tested during this simulation. This paper presents an evaluation of the experience of the various elements in this exercise. The critical matter of having a system of runners to substitute for a failure within the mobile command post is stressed. Also, the importance of adequate telephone facilities for communication with the fire/rescue stations and community hospitals is highlighted. Many other small and seemingly unimportant items are found to be of considerable significance during the handling of disasters. A strong case is made for periodic disaster simulations to maintain an efficient broadly-based apparatus for handling such disasters, should they occur (Author)

A76-29145 # **A simplified method for computing the ignition delays of hydrogen-air mixture and its experimental verification using a shock tube** K A Bhaskaran and M C Gupta (Indian Institute of Technology, Madras, India) *Aeronautical Society of India, Journal*, vol 27, May 1975, p 61-67 12 refs

The importance of ignition delay in the design of supersonic combustion systems is pointed out. A scheme for hydrogen-air (oxygen) reaction comprising of the elementary reactions believed to be important by a majority of investigators is presented. The exact chemical kinetic procedure of computing ignition delays for such a scheme is indicated. A simplified method that requires only a small fraction of the computing time taken by the exact method is explained. A comparison of the two methods reveals that, for calculating the delay periods the simplified method is just as good as the exact method. The validity of the simplified method was further checked by measuring the ignition delays of stoichiometric, lean and rich mixtures of hydrogen air using a shock tube set up (Author)

A76-29166 # **The B-1 - Strategic deterrence into the twenty-first century.** A B Martin (USAF, Aeronautical Systems Div, Wright-Patterson AFB, Ohio) *Air University Review*, vol 27, Mar-Apr 1976, p. 2-14.

The author reviews the role of the manned strategic bomber as an offensive and deterrent weapon and examines the capabilities of the Air Force's B-1 aircraft in filling this role through the rest of this century and beyond. Specific design features and test methods unique to this aircraft design are examined, and the program cost is discussed. The two chief considerations around which the design of the B-1 was centered were the ability to survive a surprise attack and the ability to penetrate. The B-1 is designed to launch in less than half the time of the B-52. It is the first aircraft specifically designed to a high blast and radiation hardness requirement. The B-1 will be able to penetrate under enemy radar near treetop level at high subsonic speeds. Some unique features of the aircraft include an electronic multiplex system (EMUX), a central integrated test system, a 240-volt power system and the 4000-psi hydraulic system. Work is well into the flight-test program, and all aircraft systems, including numerous full sweeps of the wings, have been operated. The flight envelope has been extended to the high dynamic pressure, low altitude regime. In terms of constant dollars, there has been relatively little cost growth forecast for the B-1 program - less than 12 percent from its beginning to its planned completion ten years from now P T H

A76-29191 **Agricultural and special purpose aircraft - A manufacturer's viewpoint** N D Norman (Britten-Norman /Bembridge/, Ltd, Bembridge, Isle of Wight, England) *Aeronautical Journal*, vol 80, Mar 1976, p 93-101

Operating conditions and economic considerations affecting the design of aircraft for crop spraying are discussed. Seven priority features are delineated: low capital cost per lb uplifted, strong, inexpensive, lightly stressed engine, sturdy undercarriage, low wing and power loading, good pilot view, comfort and safety, good corrosion proofing, fatigue resistant structure. The adaptation of general purpose aircraft and design of special purpose aircraft to incorporate these priority features is considered. Means of minimizing penalties associated with the dispersal equipment are described C K D

A76-29192 **The technology and economics of air transport in its next phase /Sixty-fourth Wilbur and Orville Wright Memorial Lecture/** K G Wilkinson (Rolls-Royce /1971/, Ltd, Derby, England) *Aeronautical Journal*, vol 80, Mar 1976, p 102-127 32 refs

The growth prospects for the air transport industry for the period up to 2010 are examined. A four-fold growth in passenger traffic and a ten-fold growth in freight traffic are predicted. Possible alternative fuel sources for the aircraft industry, including synthetic oil, liquid hydrogen, and nuclear energy, are discussed. The economics of research and development programs for advanced subsonic, supersonic, hypersonic, and VTOL aircraft is considered. Special attention is given to future trends in fuel conserving technologies C K D

A76-29195 # **The crack containment capability of stiffened bonded panels** V G Nanduri and K Radzins (De Havilland Aircraft

of Canada, Ltd., Downsview, Ontario, Canada) *Canadian Aeronautics and Space Journal*, vol 21, Dec 1975, p 388-400 12 refs

This paper presents results of testing and analysis of cracked skin-stringer-frame panels typical of a transport airplane fuselage. The principles of linear elastic fracture mechanics along with the finite element stress analysis technique are used to develop analytical methods for prediction of unstable failure and also crack arrest capability in thin, curved, stiffened (bonded) panels. Large panels 82 x 48 inches with a radius of 55 inches and of 2024-T3 clad and 2014-T6 clad aluminum alloys with fine sawcuts were tested under increasing pressure loads. Slow crack growth and strain gauge measurements are presented to study the crack containment capability of adhesively bonded straps and riveted frames. Correlation between test and analysis is considered satisfactory when 'K(I)' values at instability and arrest are compared. In addition, an analysis which considers the total energy of the moving crack is briefly reviewed to explain the catastrophic failure of one of the 2014-T6 panels (Author)

A76-29196 # Future military airlift requirements K E Lewis (Canadian Armed Forces, Air Transport Command, Trenton, Canada) (*Canadian Aeronautics and Space Institute, Annual General Meeting, Montreal, Canada, May 14, 1975*) *Canadian Aeronautics and Space Journal*, vol 21, Dec 1975, p 401-404

Canada's role in air transportation is examined and a review is provided of military air transport activities since World War II. The characteristics of military and civil air transportation are compared and the major planning factors confronting the military are considered. Military airlift has unique, diversified, demanding, and often unpredictable tasks to perform in support of the policies of the Canadian Government. The present air transport force is well suited for its current commitments. For the future, the Canadian Forces will require a transport fleet consisting probably of some 75 aircraft of three types G R

A76-29308 Experimental study of certain statistical vibration characteristics of an aircraft engine S G Gershman and V D Svet (Akademii Nauk SSSR, Akusticheskii Institut, Moscow, USSR) (*Akusticheskii Zhurnal*, vol 21, Sept-Oct 1975, p 711-720) *Soviet Physics - Acoustics*, vol 21, no 5, 1976, p 440-444 12 refs Translation

Experiments were conducted to determine the two-dimensional laws governing the distribution of probabilities and their parameters along with conventional spectral-correlation characteristics as related to the vibrations of a turbojet aircraft engine. A major conclusion is that the different vibration components in the various regions of the spectrum are nonlinearly correlated with each other. This nonlinear correlation is dependent on the condition of the mechanism used S D

A76-29320 * # The NASA structures and materials research program for supersonic cruise aircraft P A Cooper and R R Heldenfels (NASA, Langley Research Center, Hampton, Va) *Astronautics and Aeronautics*, vol 14, May 1976, p 26-37 50 refs

The structures and materials part of the NASA Supersonic Cruise Aircraft Research (SCAR) program is reviewed. It is pointed out that in more than three years of work significant new technology has been generated. The aircraft configurations which are efficient aerodynamically have aeroelastic problems that must be alleviated by configuration changes, active controls, or additional structural mass. An approach involving the application of advanced composite materials has the highest potential for structural weight reduction. Attention is given to the structural concepts for an arrow-wing supersonic aircraft and the techniques used in the investigations. It is expected that continuing research in SCAR structures and materials should bring high payoffs in the late 1980s G R

A76-29322 # Designing military aircraft for survival in combat R T Remers (USAF, Joint Technical Coordinating Group

on Aircraft Survivability) and R E Ball (US Naval Postgraduate School, Monterey, Calif) *Astronautics and Aeronautics*, vol 14, May 1976, p 62-64

Since 1971, a triservice organization known as the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) has served as the promoter of and repository for a rapidly developing technology to raise the survivability of aircraft weapon systems. Projects sponsored by JTCG/AS are examined, taking into account studies concerning the tolerance limits of turbofan-engine fuel ingestion, the development of thermal- and ballistic-resistant canopies, and the use of less flammable hydraulic fluids. Attention is also given to ballistic-damage tolerant flight control systems, the analytical modeling of hydraulic ram damage in fuel tanks, a survivable helicopter transmission, airflow effects on aircraft fuel fires, and the prediction of battle-damage repair time G R

A76-29480 # AWAVS - An engineering simulator for design of visual flight training simulators W S Chambers (US Navy, Naval Training Equipment Center, Orlando, Fla) In *Visual and Motion Simulation Conference*, Dayton, Ohio, April 26-28, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 26-31

The Navy AWAVS program is designed to improve visual system technology and define hardware performance requirements for training. A description is given of the visual system hardware capabilities being developed for the initial carrier takeoff and landing configuration of AWAVS. The display system provides a composite image of two TV channels. The background TV channel is a low resolution wide angle display of sky and seascape. The target TV channel's narrow field of view presents a high resolution carrier image for insertion into the displayed background channel. Each channel includes high performance perspective image generation, distortion correction and visibility effects. In addition to establishing system feasibility, the system's variability will permit investigation of the effects of visual system parameters on pilot performance in a specific task environment (Author)

A76-29494 # In flight simulation - A unique approach to flight testing an all-weather landing system R P Huber (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and P A Reynolds (Calspan Corp., Buffalo, N.Y.) In *Visual and Motion Simulation Conference*, Dayton, Ohio, April 26-28, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 145-153 8 refs

A variable stability aircraft has been used as a test bed for the development and performance evaluation of an all-weather landing system for a remotely piloted vehicle (RPV). The advantages and limitations of using a variable stability aircraft for this application are discussed. The implementation of the RPV autoland system on the total in-flight simulator (TIFS) is outlined. Included are the techniques for and the problems associated with flight simulation to touchdown and throughout rollout. Typical performance data obtained in the flight simulation are presented (Author)

A76-29496 # Advanced flight simulation in air combat training W G Spring (Northrop Corp., Hawthorne, Calif) *American Institute of Aeronautics and Astronautics, Visual and Motion Simulation Conference*, Dayton, Ohio, Apr 26-28, 1976, Paper 12 p Navy-supported research

The Large Amplitude Simulator/Wide Angle Visual System (LAS/WAVS), configured to simulate the F-4J aircraft, has been used in place of multiple aircraft simulators for initial pre-training of air combat. Outside visual attitude and rate cues are provided by an sky/earth projection system. Target image generation and target projection subsystems are used for bogey aircraft presentation. The LAS/WAVS motion base has five degrees of freedom and is capable of vertical and lateral excursions in excess of 20 ft, with rotary limits of plus or minus 25 deg on all three axes. Display features for the instructor's console include two 21 in refresh graphics CRTs, a 21 in

refresh alphanumeric CRT, a 9 in video monitor, and an electro-static printer/plotter. Limitless evaluation capability is provided by both instant and archival replay C K D

A76-29557 * Fire containment tests of aircraft interior panels D A Kourtides, J A Parker, H A Leon (NASA, Ames Research Center, Moffett Field, Calif.), R B Williamson, H Hasegawa, F Fisher, R Draemel (California, University, Berkeley, Calif.), W H Marcussen, and C J Hilado (San Francisco, University, San Francisco, Calif.) *Journal of Fire and Flammability*, vol 7, Apr 1976, p. 257-278 9 refs

The paper describes an experimental program carried out to evaluate a possible method for testing the fire-containment qualities of aircraft interior panels. The experimental apparatus consisted of a burner that simulates various fire loads under different ventilation conditions in an enclosure of approximately the same size as an aircraft lavatory module. Two fire-containment tests are discussed in which two adjoining walls of the enclosure were made from state-of-the-art composite panels, rats were exposed to the combustion products in order to evaluate the toxic threat posed by those products. The results show that the burner can be employed to represent various fire-load conditions and that the methodology developed for fire containment can be useful in evaluating the fire resistance of composite panels before conducting large-scale tests. It is concluded that elements of the fire-containment criteria include the temperature rise on the backface of the panels as a function of time, the flame burn-through by either decomposition or severe distortion of the material, and the toxicity of the combustion gases evolved F G M

A76-29586 Grumman F-14 'Tomcat'. J P Stevenson Fallbrook, Calif., Aero Publishers, Inc (Aero Series Volume 25), 1975 104 p 23 refs \$6.95

The development and major design features of the F-14 Tomcat are discussed. The aircraft has twin vertical tails to give good single engine stability and increase spin resistance. The variable-sweep wing can sweep from 20 deg full forward to 68 deg back in full flight on either an automatic or a manual mode. In the manual mode the pilot cannot select a sweep angle that will overstress the structural limit for a given airspeed. The main landing gear is part of the glove structure and can take a sink rate of 26 ft per second at 52,000 lbs. The analog and digital computers are interfaced to a Computer Signal Data Converter which acts as a central information storage point and disseminator. The design and flight characteristics of the F-14 Tomcat are compared with those of the F-4 C K D

A76-29595 Applications spectrum of data processing in development work (Anwendungsspektrum der Datenverarbeitung in der Entwicklung). K A Müller (München, Technische Universität, München, West Germany) *VDI-Z*, vol 118, no 8, Apr. 1976, p. 358-364 In German

The possibilities for an application of data processing in development work, including design operations, are examined. The development work considered involves the determination of the design characteristics for a new product and the testing of the individual product properties. The basis for this work is provided by the objectives of product planning. The development work has to supply the information needed by the production department. The development requirements are discussed along with the approaches which can be used to employ electronic data processing operations as an aid in development and design activities. Attention is given to the establishment of an integrated development system. The integration of development phases is illustrated with the aid of a concrete example related to the design of a turbine blade for an aircraft engine G R.

A76-29696 # Theory of calculating low-aspect-ratio wings, using a discretely continuous computational scheme /matrix differen-

tial equation for additional displacements/ (Teoriya rascheta kryla malogo udlineniya po diskretno-kontinual'noi raschetnoi skheme /matrichnoe differentsial'noe uravnenie dopolnitel'nykh peremeshchenii/) M B Vakhitov and N. G Larionov *Aviatsionnaya Tekhnika*, vol 18, no 4, 1975, p. 44-51 5 refs. In Russian

Additional tangential displacements lead to deformations of the wing ribs, leading to distortions of the wing cross section. In the mathematical model proposed, the ribs within a wing section are treated as a continuously distributed medium whose rigidity is equivalent to the combined rigidity of the ribs. The derived matrix differential equation for the additional displacements forms, together with a previously obtained equation (Vakhitov and Larionov, 1975), a closed system for calculating all unknown displacements. The boundary conditions are obtained, along with conditions for joining the wing sections with respect to discrete ribs V P

A76-29697 # Calculation of the natural vibrations of thin-walled aircraft structures (K raschetu svobodnykh kolebaniy tonkostennykh aviatsionnykh konstruktov). M B Vakhitov, M S. Safariev, and A S Safonov *Aviatsionnaya Tekhnika*, vol 18, no 4, 1975, p. 52-57 12 refs. In Russian

A method is proposed for calculating the natural vibrations of a reinforced slightly conical shell with rigid transverse diaphragms. The method is developed on the basis of an extension of Odonkov's (1948) theory of thin-walled structures to the case of dynamic loading. Numerical solutions are obtained with the aid of the formalism of integrating matrices. The problem is reduced to the determination of the eigenvalues and eigenvectors of a dynamic matrix. The equation obtained takes into account the deformational behavior of a thin-walled structure associated with irregularities, shear strains, etc V P

A76-29699 # Parametric studies of a triple-slotted flap (Parametricheskie issledovaniya trekhzvennogo zakrylka) Iu S Evdochenko *Aviatsionnaya Tekhnika*, vol 18, no 4, 1975, p. 63-68 5 refs. In Russian

Experimental data concerning the influence of the flap angle relation and the relation of the dimensions of the elements of a triple-slotted flap on the aerodynamic characteristics of a wing are reviewed. The optimal flap angles are determined from the condition for attaining maximum lift. The characteristic features of the influence of the chord and the flap dimensions on the aerodynamic characteristics of the wing are determined, and the aerodynamic characteristics of a wing with double-slotted and triple-slotted flaps are compared V P

A76-29700 # Flutter study for an elastic helicopter-rotor blade, using an analog computer (Issledovanie flattera uprugoi lopasti vertoleta na analogovoi vychislitel'noi mashine) K D. Egorov, V P Kandidov, and S. A Pulnits *Aviatsionnaya Tekhnika*, vol. 18, no 4, 1975, p. 69-76 11 refs. In Russian.

The dynamics of a rotating rotor blade is analyzed by a finite element technique developed for one dimensional systems in a centrifugal force field. The blade model (composed of finite elements) is studied by analog simulation. A relation between the blade vibration frequencies and the rpm is derived, and the behavior of the system's eigenvalues during hover and during flight is studied. The critical values of the flight parameters are determined V P

A76-29703 # Hypersonic flow past a three-dimensional wing (Giperzvukovoe obtekanie prostranstvennogo kryla) V V. Kravets and V K Khrushch *Aviatsionnaya Tekhnika*, vol 18, no 4, 1975, p. 94-100 6 refs. In Russian

The attached hypersonic flow at incidence past a thin-section wing with a leading edge of arbitrary planform is analyzed, using a generalized formulation of the problem. A solution is obtained in the form of a series in powers of a small parameter. The wave-drag and lift coefficients are obtained in final form to within terms of second

power in the small parameter. The shape of the shock wave and the parameters within the shock layer are expressed in quadratures. The calculations can be readily extended to flows past large-aspect-ratio wings. V P

A76-29704 # Evaluation of the influence of diffusion of vortices on the separated flow past a plate (Otsenka vlianiia diffuzii vikhrei na sryvnoe obtekanie plastiny) M I Nisht *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 101-105 9 refs. In Russian

The influence of the diffusion of vortices on the aerodynamic characteristics of a plate and on the structure of the slipstream behind the plate is evaluated numerically for the case of shock stalling in an incompressible medium. Allowance for diffusion is made by introducing a viscous term in the equations of vortex propagation. Example calculations for various Reynolds numbers are presented, and the data are compared. It is shown that diffusion of vortices, taken into consideration in the manner proposed, provides a qualitative description of the experimentally obtained characteristics of viscous separated flows. V P

A76-29705 # Application of Liapunov's direct method to nonlinear problems of stabilizing aircraft lateral motion (O primeneni priamogo metoda Liapunova k nelineinym zadacham stabilizatsii bokovogo dvizheniia letatel'nogo apparata) L G Romanenko and S V Krivosheev *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 106-110. In Russian

The absolute stability of the trivial solution of the equations of lateral motion of an aircraft employing an automatic bank regulator is analyzed, assuming that the actuator of the bank regulator has a nonlinear rate characteristic. The conditions for absolute stability are obtained by applying Liapunov's direct method to the system of equations composed of the equations of perturbed motion of the aircraft and the equation the bank regulator. V P

A76-29706 # The optimum trajectories of programmed stable motion of an aircraft (O naivygodneishikh traektoriiakh programmnoogo ustoiichivogo dvizheniia letatel'nogo apparata) V A Sgilevskii *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 111-115 5 refs. In Russian

The problem of optimizing stable programmed motion for an aircraft is compared with the more general problem for a heavy point of variable mass. The problem for the case of an aircraft is complicated by the dependency of the control functions on the characteristics of the aircraft and its engines. The elaboration of the two control functions, one of which ensures the condition of stable completion of the program and the other of which ensures optimal motion according to a selected criterion, permits the synthesis of the optimal controls for an aircraft with a known structure. C K D

A76-29708 # Computation of the aerodynamic characteristics of a body with compound carrier surfaces in the presence of high supersonic flow velocities (K raschetu aerodinamicheskikh kharakteristik tel s sostavnymi nesushchimi poverkhnostiami pri bol'shikh sverkhzvukovykh skorostiakh potoka) S S Barkov and L P Pashkevich *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 120-122. In Russian

The problem of gas flow around a body with compound carrier surfaces at large supersonic velocities is examined. An approximate solution is suggested which may be used in predicting the aerodynamic characteristics of such a body in cases where application of Newtonian theory gives unsatisfactory results or in which the application of the exact jump theory involves unwieldy calculations. The theoretical results are in good agreement with experiment for Mach numbers greater than 3 and local angles of attack smaller than 30. C K D.

A76-29710 # Evaluation of the generalized geometrical parameter of a triple-slotted wing flap (K otsenke obobshchennogo

geometricheskogo parametra mnogozvennoi mekhanizatsii kryla) A I Matiazh, V A Popov, and V A Sterlin *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 126-131. In Russian

To evaluate the effectiveness of a trailing-edge triple-slotted flap, it is proposed to use a geometrical parameter in the form of the reduced flap angle that takes into account the chord length and the angles of the flap elements. The feasibility of using the proposed parameter in practice is demonstrated by wind tunnel tests. It is shown that the experimental diagrams can be satisfactorily approximated by analytical expressions whose form is defined by the reduced flap angle. V P

A76-29711 # Calculation of a tail unit with a distributed reaction (Raschet operenii s raspredelennoi reaktsiei) V A Pavlov and V I Savinov *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 131-134. In Russian

The problem of determining the aerodynamic reaction distributed along the hinge of a horizontal control surface is solved with allowance for the pliability of the stabilizer and control-surface joints. The equilibrium equations derived are reduced to a single resolvent linear differential equation. An analytical solution is obtained for a tail unit of constant cross section. Plots showing the distribution of the bending moment, the shearing force, and the distributed reaction over the control surface are presented. V P

A76-29712 # The influence of the type of fitting on the stress state and weight of a wing (Vlianie kharaktera zakreplenii na napriazhennoe sostoianie i ves kryla). Iu I Popov *Aviatsionnaia Tekhnika*, vol 18, no 4, 1975, p 134-137. In Russian

The selection of the type of fitting for a three-spar straight wing is examined on the basis of strength and weight analyses. Two variants are compared: moment fitting at all three spars, and moment fitting of the center spar only, with hinge fitting at the two edge spars. It is shown that moment fitting at all three spars gives better distribution of tangential forces and stress along the cord of the wing than that obtained with the single moment fitting. The two variants are about equally desirable in terms of weight. C K D

A76-29789 # Approximate methods for transonic flow past finite wedge profiles. D D Liu (Lockheed-Georgia Co., Marietta, Ga.) and M F Platzer (US Naval Postgraduate School, Monterey, Calif.) *Zeitschrift für angewandte Mathematik und Mechanik*, vol 56, Jan 1976, p 51-57 13 refs. Research supported by the University of Southampton

Solutions to the transonic small perturbation equation are obtained by approximating the velocity perturbation potential by suitably chosen decaying functions in the lateral direction. Two related methods are used to reduce the partial differential equation to nonlinear ordinary differential equations. Closed form solutions of these equations are then obtained showing that a different choice of the decaying function only affects the drag, but not the pressure behavior. Comparisons with other theories are also given. (Author)

A76-29866 # Elastomeric propeller bearings (Smiglowcowe lozyska elastomerowe) Z Brodzki *Technika Lotnicza i Astronautyczna*, vol 31, Mar 1976, p 14-16. In Polish

The article reviews the applications, advantages, and testing of elastomeric bearings used in propeller and helicopter rotor assemblies. Roller and needle bearings are common, elastomer ball bearings are rare. Programs of fatigue testing and endurance testing of elastomeric bearings, on the test stand and in flight, are discussed. The elastomeric bearings are recommended for their attenuation of vibrations, adjustment to wear, monitorability of wear, compact size, endurance, ease of maintenance, simple design, and handling of alternating loads. Comparisons of the performance of standard bearings and elastomeric bearings under sudden changes in load and in response to bending forces are cited. R D V

A76-29868 # Suspension of an aircraft during test-stand resonance trials (Zawieszenie samolotu podczas prob rezonansowych). W Wisniowski *Technika Lotnicza i Astronautyczna*, vol 31, Mar 1976, p 25-27 5 refs In Polish.

Alternate types of aircraft suspension for resonant vibration tests are described and compared The advantages and drawbacks of an elastic rubber-band suspension rig, suspension of the aircraft with elastic support provided by the deflated tires of its own undercarriage, and pneumatic suspension with overpressure are compared Particular attention is given to the effect of suspension stiffness on the test parameters, and to the effect of additional vibrations generated by the suspension in distorting the vibration pattern of the free aircraft The lifting capacity and compliance of the suspension rig are important, and keeping the frequencies of the rig-generated vibrations low facilitates distinguishing these vibrations from vibrations experienced by the aircraft in free flight The resonant vibration test results are important for dynamic and aerodynamic (flutter) calculations R D V

A76-29869 # Onboard instrumentation for gliders I (Szybowcowe przyrzady pokladowe I) E Babiasz (Instytut Lotnictwa, Warsaw, Poland) *Technika Lotnicza i Astronautyczna*, vol. 31, Mar 1976, p 31-34 In Polish

Glider pilots' needs for information and navigation aids are surveyed with attention given to the peculiar features of glider flight and navigation, and contrasted with instrumentation required in powered aircraft Information on maneuvering points, cloud formations, wind velocity and wind direction, updrafts, movement of air masses, air temperature, altitude requiring an oxygen mask, and data needed for the proper execution of glider maneuvers are required Glider handling information includes altitude, speed, position of control elements (valves, brakes, landing gear), attitude of glider, angular velocity, vertical velocity, skids, and dips Details of West German, Finnish, and Swedish glider instrument panels are shown R D V

A76-30005 # 1976 technology options for cost-effective design R C Goran (McDonnell Aircraft Co., St. Louis, Mo.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 1-15 16 refs

The subject is defined in relation to current 'Design to Cost' principles of the Department of Defense Though started prior to formal Design to Cost contracting, management of the F-15 program has followed Design to Cost practices from its inception and F-15 cost effective design examples in the fields of structures, dynamics and materials are reviewed Composite structures, titanium technology, ion vapor deposition of aluminum, computer aided design and manufacturing (CAD/CAM), fracture technology applications, and a pertinent flutter problem solution are the specific subjects selected for review (Author)

A76-30008 # Fracture control in composite materials using integral crack arresters T E Hess, S L Huang, and H Rubin (US Naval Material Command, Naval Air Development Center, Warminster, Pa.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 52-60

A study is conducted to investigate and develop crack arrester designs for composite materials which will locally contain cracks and damage, thereby allowing an aircraft and crew to safely return to base for repair or replacement of damaged parts It is shown that crack arrester strips successfully arrest propagating cracks in graphite-epoxy and graphite/glass-epoxy hybrid composites The important failure modes governing their behavior are identified and investigated both analytically and experimentally A limited design base for one material system is developed with a relatively good degree of

accuracy Tradeoff studies indicate that the ability to sustain large damage sizes (8-10 in.) can be built into an advanced composite structure using integral crack arrester strips with very small weight penalty Future areas of investigation are noted S D

A76-30009 # Aeroelastic tailoring of composite materials to improve performance R W Lynch and W A Rogers (General Dynamics Corp., Fort Worth, Tex.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 61-68 USAF-sponsored research

The paper outlines the state of the art of aeroelastic tailoring as a tool to improve aircraft performance Aeroelastic tailoring of composite materials is the control of the direction and degree of aeroelastic deformation by the distribution and orientation of the unidirectional plies Tailoring can also be used to achieve wing designs with higher span and lower thickness ratios than metal designs An integrated design algorithm is developed for determining wing box laminate configurations of composite materials that satisfy aeroelastic-strength criteria The potential of aeroelastic tailoring is demonstrated for composite wing designs categorized as constant orthotropic, nonconstant orthotropic, constant anisotropic, and nonconstant anisotropic The use of anisotropic composites is at its best when used to improve flutter, divergence, strength, control effectiveness, and aeroelastic drag problems without changing the weight S D

A76-30010 # Aeroelastic tailoring of advanced composite lifting surfaces in preliminary design. F Austin, R Haddock, D Hutchings, D Sharp, S Tang, and C Waters (Grumman Aerospace Corp., Bethpage, N.Y.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 69-79 7 refs Research sponsored by the Grumman Independent Research and Development Program, Contract No F33615-75-C-3124

A procedure is described for carrying out rapid tradeoff studies among weight, cost, and performance of candidate advanced-composite lifting surfaces in the early stages of aircraft development The input data include a spanwise torsional stiffness distribution as well as the desired angles of attack at each station along the span for one or two different loading conditions The procedure employs simple box-beam theory which is extended to include the coupling between bending and twisting induced by the anisotropic covers Results are presented for the wing and vertical stabilizer of an advanced design composite aircraft It is found that the procedure described proves useful in rapidly eliminating unfeasible designs from further consideration S D

A76-30016 # A new titanium alloy for cost-effective design of military aircraft - Ti-4 5Al-5Mo-1 5Cr R G Berryman (Rockwell International Corp., Los Angeles Aircraft Div., El Segundo, Calif.), J C Chesnutt (Rockwell International Science Center, Thousand Oaks, Calif.), F H Froes (Crucible Materials Research Center, Pittsburgh, Pa.), and J C Williams (Carnegie-Mellon University, Pittsburgh, Pa.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 120-125 Contracts No N00019-73-C-0335, No N00019-74-C-0273, No N00019-75-C-0208

A new titanium alloy, CORONA-5 (Ti-4 5Al-5Mo-1 5Cr), has been developed for application in fracture-controlled aircraft parts Plane strain fracture toughnesses of 110 to 140 ksi times inch to 1/2 power have been produced at 135 ksi UTS, minimum, over a wide range of processing histories Modulus and specific strengths (ratioed to density) are superior to those of the widely used Ti-6Al-4V in similar applications, while fatigue crack propagation and chloride

stress corrosion resistances are essentially equivalent to those of Ti-6Al-4V. This alloy is readily fabricated to hot-rolled plate and forgings. Use of the new alloy can result in cost savings associated with relaxed processing control requirements and reduced quality control verification testing to the current fracture toughness requirements. (Author)

A76-30017 # Development and application of marker loads for a fatigue crack growth study on a full-scale test article D M Anderson and W M McGee (Lockheed-Georgia Co, Marietta, Ga) In Structures, Structural Dynamics, and Materials Conference, 17th King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 126-132

Crack growth tests and fractographic examinations were performed to develop a marker loading technique for application on a full-scale cargo airplane wing. The technique developed allowed determination of crack growth history by post test fractographic examinations. Relatively few additional cycles were required in the fatigue spectrum, and the impact on growth rate and crack life was considered negligible. Results obtained during technique development are presented. Also presented are fracture surface-derived crack growth data for the full-scale airplane wing on which the technique was applied. (Author)

A76-30020 # Fatigue analysis of mechanically fastened joints utilizing PSD loads B M Shah and J L Russ (Lockheed-Georgia Co, Marietta, Ga) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 151-157 8 refs

An evaluation of multicomponent wing load and derived internal stress time histories with consideration of load transfer through mechanically fastened joints is used to develop a fastener load transfer fatigue analysis. The suggested technique includes gust loads in the power spectra density form. A matrix of axial-shear stress phasing relationships based on variations in operational flight parameters is constructed. Results are obtained for structural joints subjected to two different load spectra and compared with results of a fatigue assessment using a uniaxial-stress fatigue analysis procedure. C K D

A76-30026 # The computer aided design/drafting /CADD/ system - Applications and economic factors in the design/manufacturing process L E Schultz (McDonnell Douglas Astronautics Co, St Louis, Mo) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 204-208

A brief description is given of a computer-operated, three-dimensional graphic system and associated equipment used in Advanced Design, Production Design and Manufacturing activities at the McDonnell Douglas complex. The CADD system is shown to exist as one element of this overall system, and several applications are presented to illustrate the kinds of design problems solved. Qualitative and quantitative economic parameters are also discussed, and their relationships presented. It is shown that subjective (qualitative) economic parameters are not convertible to monetary values, but that these parameters have at least equal importance with those that are quantitative. (Author)

A76-30027 * # Actively cooled airframe structures for high-speed flight R J Nowak and H N Kelly (NASA, Langley Research Center, Structures and Dynamics Div, Hampton, Va) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 209-217 20 refs

An assessment of forced convectively cooled aircraft structures is presented based on recent and on-going studies. Particular emphasis is given to contractual efforts in which large panels of three different concepts are being designed and fabricated for cyclic thermal-structural tests at the Langley Research Center. Results of ambient temperature fatigue tests of small specimens of these concepts are reviewed. Aspects of conceptual and detail designs, material selection, fabrication, reliability, and heat-load/hydrogen fuel heat-sink matching are discussed. Results to date indicate that active cooling significantly impacts the structural design process, and, despite the use of conventional aluminum materials, advanced complex fabrication processes are required. (Author)

A76-30028 # Development of a graphite reinforced thermoplastic design concept for a target drone aircraft fuselage structure application J H Laakso and J T Hoggatt (Boeing Aerospace Co, Seattle, Wash) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 218-228 12 refs Contract No N62269-74-C-0368

The design and fabrication of three prototype components (a door, a right side skin, and a left side skin) for the XBQM-34E is discussed. A 26% cost saving was offered by the use of a concept based on a graphite reinforced polysulfone composite over a conventional aluminum design. Stock laminate sheets, low-cost tooling, and simple thermo-forming methods were used in fabricating the component parts. Structural analyses confirmed their integrity for the XBQM-34E design conditions. The graphite reinforced thermoplastic components offer a 5% weight saving in this application. The components sustained the limit load condition associated with chute recovery in ground testing. Analysis of the measured strains showed that the load capabilities of the components exceed their ultimate load requirements. C K D

A76-30036 # Structural analysis of a cooled, directionally solidified turbine blade E E Abell, R E Kielb, and P J Henderson (USAF, Aeronautical Systems Div, Wright-Patterson AFB, Ohio) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 291-297 8 refs

Directionally solidified, air-cooled turbine blades present new challenges to the structural design analyst. This paper describes an investigation of turbine blade failures encountered during a recent engine development program. The effect of wall tolerance variations on steady and vibratory stresses was determined using finite element methods (NASTRAN) combined with engine test data. This procedure successfully determined the failure mechanism and verified the subsequent redesign. (Author)

A76-30045 # Aeroelastic airframe transfer function synthesis T D Arthurs, R R Tye, and B A Winther (Northrop Corp, Aircraft Div, Hawthorne, Calif) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 383-388 12 refs

A computerized procedure for deriving closed form approximations to aeroelastic airframe transfer functions is described. The transfer functions are synthesized from discrete frequency response data as ratios of polynomials in the complex variable s . They include the effects of inertial, elastic and oscillatory aerodynamic forces. The method has been applied to analysis of a modern fighter aircraft which encountered unstable coupling between flight control system and airframe dynamics during development testing. Analytical results are presented together with correlative flight test data. Potential applications in other areas such as ground simulation and active control technology are discussed. (Author)

A76-30046 # Flutter and gust response analysis of flexible aircraft with active control R B Noll (Aerospace Systems, Inc., Burlington, Mass.) and L Morino (Boston University, Boston, Mass.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 389-397 14 refs

The equations of motion of a flexible aircraft with an active control technology (ACT) system are developed to evaluate the stability and performance of the controlled aircraft. Formulation of the total aircraft system is accomplished in matrix form by casting the equations in state vector format. Fully unsteady aerodynamics based on the program SOUSSA is used for flutter and gust response analyses. The system equations are incorporated in the digital computer program FCAP (Flight Control Analysis Program). Gust response analysis is available in either the time or frequency domains. Flutter analysis is implemented by a modified version of classical flutter solution techniques (Author)

A76-30047 * # Effect of modified aerodynamic strip theories on rotor blade aeroelastic stability. P Friedmann and C Yuan (California, University, Los Angeles, Calif.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 398-411. 25 refs Grant No NGR-05-007-414

Various existing unsteady aerodynamic strip theories which have been developed in the past for both fixed and rotary wing aeroelastic analyses are modified in the paper so as to make them applicable to the coupled flap-lag-torsional aeroelastic problem of a rotor blade in hover. These corrections are primarily due to constant angle of attack, constant inflow and variable free stream velocity due to lead-lag motion. Next, the modified strip theories are incorporated in a coupled flap-lag-torsional aeroelastic analysis of the rotor blade in hover and the sensitivity of the aeroelastic stability boundaries to the aerodynamic assumptions is examined (Author)

A76-30048 # Stability of hingeless rotor blades in hover with pitch-link flexibility D H Hodges and R A Ormiston (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 412-420 9 refs

A stability analysis of a single cantilevered helicopter rotor blade in hover is presented. The blade is represented by an elastic uniform beam, cantilevered in bending and having a torsional root spring to simulate pitch-link flexibility. Nonlinear equations are adapted for a linearized stability analysis about the blade equilibrium operating condition. Numerical results are obtained for hingeless rotor configurations having pitch-link flexibility, precone, droop, twist, and flap-lag structural coupling. The results indicate that hingeless rotor stability characteristics are sensitive to changes in most configuration parameters. For a given torsion frequency, the effect of pitch-link flexibility is generally found to be similar to the effect of blade torsional flexibility. Droop and precone, although physically similar, exhibit different effects on stability when pitch-link flexibility is present. Twist is shown to influence the stability by altering the flap-lag structural coupling. (Author)

A76-30049 * # An investigation of flap-lag stability of wind turbine rotors in the presence of velocity gradients and helicopter rotors in forward flight K R V Kaza and C E Hammond (NASA, Langley Research Center, Hampton, Va.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 421-431 15 refs

The flap-lag equations of motion of a torsionally rigid and centrally hinged spring-restrained rigid blade are developed using quasi-steady blade-element aerodynamic theory. These equations have periodic coefficients and are applicable to both wind-turbine rotors with velocity gradients and helicopter rotors in forward flight. By solving these equations both by the Floquet-Liapunov method and by an approximate method, the range of applicability of the latter method is established. Flap-lag and pure flapping stability boundaries illustrating the effects of flow and rotor parameters are presented. Finally, some discussion on the techniques for generating the Floquet transition matrix and on the relative merits of the coordinate axes system is presented (Author)

A76-30050 * # An advanced structural analysis/synthesis capability - ACCESS 2 L A Schmit and H Miura (California, University, Los Angeles, Calif.) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 432-447 17 refs Grant No NGR-05-007-337

An advanced automated design procedure for minimum-weight design of structures (ACCESS 2) is reported. Design variable linking, constraint deletion, and explicit constraint approximation are used to combine effectively finite-element and nonlinear mathematical programming techniques. The approximation-concepts approach to structural synthesis is extended to problems involving fiber composite structure, thermal effects, and natural frequency constraints in addition to the usual static stress and displacement limitations. Sample results illustrating these features are given (Author)

A76-30051 * # Optimization of multi-constrained structures based on optimality criteria P Rizzi In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 448-462 42 refs Grants No AF-AFOSR-74-2712, No NGL-05-020-498

A weight-reduction algorithm is developed for the optimal design of structures subject to several multibehavioral inequality constraints. The structural weight is considered to depend linearly on the design variables. The algorithm incorporates a simple recursion formula derived from the Kuhn-Tucker necessary conditions for optimality, associated with a procedure to delete nonactive constraints based on the Gauss-Seidel iterative method for linear systems. A number of example problems is studied, including typical truss structures and simplified wings subject to static loads and with constraints imposed on stresses and displacements. For one of the latter structures, constraints on the fundamental natural frequency and flutter speed are also imposed. The results obtained show that the method is fast, efficient, and general when compared to other competing techniques. Extensions to the generality of the method to include equality constraints and nonlinear merit functions is discussed (Author)

A76-30052 # Application of the flutter and strength optimization program /FASTOP/ to the sizing of metallic and composite lifting-surface structures K Wilkinson, J Markowitz, E Lerner, D George (Grumman Aerospace Corp., Bethpage, N.Y.), and S M Batill (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 463-472 5 refs Contract No F33615-72-C-1101.

A computer program entitled FASTOP is described, and results obtained from its application to the structural sizing of three lifting-surface structures for combined strength and flutter-speed requirements are presented. Two detailed finite-element models of metallic structures (having between 600 and 900 elements) and a preliminary design representation of an advanced composite wing are considered. Near-minimum-weight designs are achieved in only six combined-strength and flutter-resizing cycles for the two metallic

structures, one of which includes mass-balance design variables. For the composite wing, FASTOP is used to resize the individual ply thicknesses of a strength-based design for increased flutter speed, the same excellent convergence characteristics are demonstrated

(Author)

A76-30054 # Developing methods for tracking crack growth damage in aircraft. J P Gallagher and H D Stalnaker (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 486-494 10 refs

This paper directs attention to the interrelationship between crack-growth (NCG) curve concept used in the F-4 fighter damage-tracking program. Crack-growth rate equations, based on linear elastic fracture mechanics assumptions, provide the capability for predicting the influences of geometrical changes or of stress scaling. For the crack growth rate equations which describe the flight-by-flight generated data presented herein, generalized integral (or inverted) formulas are suggested which provide the rationale for developing NCG curves. Subject to the limitations described, the NCG curve invariance assumption for tracking damage at different locations in an aircraft appears reasonable

(Author)

A76-30055 # A new model of fatigue crack propagation using a material flaw growth resistance parameter. H C Hagendorf (Lehigh Associates, Hawthorne, Calif.). In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 495-521 23 refs

A model of fatigue crack propagation is presented which is based on the characterization of subcritical flaw-growth phenomena in structural materials by the stress intensity rate. It is shown that under constant-amplitude fatigue loads, a functional relationship between the physical flaw-growth response and fatigue crack growth is independent of the maximum cyclic stress, stress ratio, crack size, and configuration of the cracked body. Experimental verification of this model establishes a material constant, H, which uniquely characterizes the subcritical flaw-growth behavior resistance for a given material-environment system. A theoretical service-life equation is obtained which indicates that fatigue life is directly proportional to a material's subcritical flaw-growth resistance and that the H parameter is essential in service-life-cycle analysis of tension-critical mechanical and aerospace structural components. The theoretical flaw-growth rate equation is shown to demonstrate that the scatter intrinsic in the conventional method of correlating fatigue crack growth behavior in structural materials is due primarily to the fatigue-stress variables

F G M

A76-30060 * # Optimal periodic proof test based on cost-effective and reliability criteria. J-N Yang (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 567-576 27 refs. Grant No. NSG-1099

An exploratory study for the optimization of periodic proof tests for fatigue-critical structures is presented. The optimal proof load level and the optimal number of periodic proof tests are determined by minimizing the total expected (statistical average) cost, while the constraint on the allowable level of structural reliability is satisfied. The total expected cost consists of the expected cost of proof tests, the expected cost of structures destroyed by proof tests, and the expected cost of structural failure in service. It is demonstrated by numerical examples that significant cost saving and reliability improvement for fatigue-critical structures can be achieved by the application of the optimal periodic proof test

The present study is relevant to the establishment of optimal maintenance procedures for fatigue-critical structures (Author)

A76-30063 * # Geared-elevator flutter study. C L Ruhl, R V Doggett, Jr (NASA, Langley Research Center, Structures and Dynamics Div., Hampton, Va.), and R A Gregory (Boeing Commercial Airplane Co., Seattle, Wash.). In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 598-607 5 refs

The paper describes an experimental and analytical study of the transonic flutter characteristics of an empennage flutter model having an all-movable horizontal tail with a geared elevator. Two configurations were flutter tested: one with a geared elevator and one with a locked elevator with the model cantilever-mounted on a sting in the wind tunnel. The geared-elevator configuration fluttered experimentally at about 20% higher dynamic pressures than the locked-elevator configuration. The experimental flutter boundary was nearly flat at transonic speeds for both configurations. It was found that an analysis which treated the elevator as a discrete surface predicted flutter dynamic pressure levels better than analyses which treated the stabilizer and elevator as a warped surface. Warped-surface methods, however, predicted more closely the experimental flutter frequencies and Mach number trends

(Author)

A76-30064 * # Comparison of supercritical and conventional wing flutter characteristics. M G Farmer and P W Hanson (NASA, Langley Research Center, Hampton, Va.). In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 608-614

A wind-tunnel study is described in which it was attempted to compare the measured flutter boundaries of two dynamically similar aeroelastic models with identical planform, maximum thickness-to-chord ratio, and as nearly identical stiffness and mass distributions as possible, but with one wing having a supercritical airfoil and the other a conventional one. At subsonic Mach numbers, the flutter boundary for the supercritical wing was above that of the conventional wing, as predicted by flutter calculations using subsonic lifting theory. In the transonic region, however, the supercritical wing boundary decreases more rapidly and the minimum flutter point occurs at a dynamic pressure below the conventional wing boundary. Airfoil shape effects may account for some of the difference in the flutter boundaries of the two airfoils

P T H

A76-30065 # An improved Mach-box approach for the calculation of supersonic oscillatory pressure distributions. R R Chipman (Grumman Aerospace Corp., Bethpage, N.Y.). In Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976, p 615-625 16 refs

An analytical refinement of the Mach-box approach has been developed which provides greatly improved supersonic oscillatory pressure distributions with almost no increase in computer time over that required by the original formulation. The refinement consists, in part, of applying physically justifiable weighting factors to the terms of the aerodynamic influence coefficient matrix. Unlike approaches that employ curve smoothing to eliminate the erratic undulations in computed pressures obtained by the basic method, the present analysis produces well-behaved pressure distributions while retaining essential flow discontinuities. Furthermore, the present method is more cost-effective than approaches relying on refinements in the aerodynamic grid to obtain comparable improvements in the calculated pressures

(Author)

A76-30066 * # Fully unsteady subsonic and supersonic potential aerodynamics of complex aircraft configurations for flutter applications. K Tseng and L Morino (Boston University, Boston, Mass.). In Structures, Structural Dynamics, and Materials Confer-

ence, 17th, King of Prussia, Pa, May 5-7, 1976, Proceedings New York, American Institute of Aeronautics and Astronautics, Inc, 1976, p 626-638 22 refs Grant No NGR-22-004-030

The paper presents a general theory of steady, oscillatory or fully unsteady, subsonic and supersonic aerodynamics for aircraft of arbitrary shape. The finite element method is used to obtain the time functional relationship between aerodynamic potential and its normal derivative (normal wash) in a form suitable for computational analysis. The matrix of the aerodynamic influence coefficients, as necessary for flutter calculations, is obtained as a result. The theory is implemented in a computer program, and some typical results obtained with this program are presented. P.T.H.

A76-30242 F-16 - Swing-force fighter for the '80s. R. G. H. Carroll *Air Force Magazine*, vol 59, Apr 1976, p 30-35

The high performance qualities plus low cost of the F-16 Air Combat Fighter are emphasized. The F-16 replaces the F-4, and will supplement the F-15. The advantages of the F-16 over the F-4 are reviewed (lower replacement cost, lower weight, smaller turning radius, less maintenance time, lower operating costs, lower support costs). Other advantages emphasized are capability of handling air combat missions and ground support missions with equal facility, nuclear weapons capability, ground-mapping radar, ability to be ferried (with mid-air refueling) over a 2000-mile stretch mission-ready to a distant base, impressive foreign sales potential, and double the combat radius. The advanced engine (25000 lb thrust) contributes to fuel economy, high thrust/weight ratio, and expanded range. Target acquisition and lock-on by the radar system are described.

R.D.V.

A76-30424 # Helicopter version of the RDS-2 system (Ver-toletnyi variant sistemy RDS-2) Iu. G. Bugaev, A. S. Maslennikov, and A. V. Savel'ev *Geodeziia i Kartografiia*, Feb 1976, p 47-50. In Russian.

The characteristics of the RDS-2 system for determining the coordinates of landscape points by the method of linear cross bearings are studied in the case where the master station is mounted on a helicopter. It is shown that the 'helicopter version', in spite of some drawbacks, can provide improved accuracy and savings in computer time. Tests also showed that the accuracy of coordinate determination depends on the flight altitude and on the accuracy of sighting-angle measurement with an optical sight. V.P.

A76-30471 # Delta wing in hypersonic gas flow (O treugol'nom kryle v giperzvukovom potoke gaza). A. I. Golubinskii and V. N. Golubkin (Tsentr'al'nyi Aerogidrodinamicheskii Institut, Moscow, USSR) *Akademiia Nauk SSSR, Doklady*, vol 226, Feb 1, 1976, p 789, 790. 6 refs. In Russian.

The authors consider the flow past the undersurface of a flat delta wing of small aspect ratio, placed at a finite angle of attack in the hypersonic flow of an ideal gas. A solution is constructed in the first approximation to the initial Newtonian flow past the wing with attached compression shock, whereby the density ratio at the shock is employed as a small parameter. Equations and boundary conditions for gasdynamic parameters in the transverse plane $x = 1$, obtained in accordance with the hypersonic law of plane sections for thin bodies at high angle of attack by Messiter (1963) and Golubinskii (1968), are used. The analysis is based on the idea that the peripheral part of the wing coincides with some stream surface, while the central part is a singular conical stream surface with variable stream function along it. P.T.H.

A76-30515 # Investigation of the dynamics of aircraft descent at a constant flight path angle (K issledovaniu dinamiki spуска letatel'nogo apparata s postoiannym uglom naklona traektorii) O. A. Privarnikov *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo*

Tela, Jan-Feb 1976, p 41-44. In Russian.

The plane angular descent at a constant flight path angle is analyzed for an aircraft subjected to perturbing and control moments. It is shown that the differential equation of the transient process can be reduced to Whittaker's inhomogeneous equation. Approximate analytical relations describing the variation of the angle of attack with height are derived for the case of a nonoscillating transient process. V.P.

A76-30625 # Some future trends in aero engine design for subsonic transport aircraft. A. J. B. Jackson (Rolls-Royce /1971/, Ltd, Derby, England) *American Society of Mechanical Engineers, Gas Turbine Conference, Houston, Tex., Mar 2-6, 1975, Paper 75-GT-2* J. ASME, Transactions, Series A - Journal of Engineering for Power, vol 98, Apr 1976, p 281-289. 7 refs.

The problems presented to the aero engine designer by the decreasing world oil and aviation fuel supplies and by noise and pollution regulations are discussed. It is shown that a key parameter for subsonic transport aircraft is specific fuel consumption. The propulsive efficiency element in specific fuel consumption is considered in detail. Some of the technical parameters which will influence the choice of specific thrust (bypass ratio) in the next generation of engines are examined, including installation standard, engine weight, cruise to take-off thrust ratio, and engine noise. The effect of specific thrust on direct operating costs and payload range is discussed. It is concluded that potential gains in direct operating costs and payload range will come primarily from means other than increasing propulsive frequency by reduction of specific thrust. C.K.D.

A76-30630 New theoretical developments on the wings with lateral jets. E. Carafoli (Bucuresti, Institutul Politehnic, Bucharest, Rumania) and M. Neamtu (Institutul de Mecanica a Fluidelor si Constructii Aerospatiale, Bucharest, Rumania). In *In honor of Carlo Ferrari*. Turin, Libreria Editrice Universitaria Levrotto e Bella, 1974, p 87, 89-114. 10 refs.

The paper presents a study of hypersustentation, a complex aerodynamic lift phenomenon produced by lateral jets on small aspect ratio wings. The theoretical investigation is based on the notion that the effect of increased lift is due to the increase in circulation caused by the distortion of the lateral jet sheet which can be viewed as an extension of the wing span. Fundamental relations of the lateral jet sheets are considered and a lifting surface model for the region in the slot vicinity of the jet sheet is formulated. A lifting line model of a wing with lateral jets is presented and the hypersustentation produced by lateral jets is calculated. B.J.

A76-30634 Impulse theory of a helicopter rotor (Teoria impulsiva del rotore di un elicottero). S. D'Angelo, M. Laudanna, B. Piombo (Torino, Politecnico, Turin, Italy), and F. Quori (CNR, Centro Studi sulla Dinamica dei Fluidi, Turin, Italy). In *In honor of Carlo Ferrari*. Turin, Libreria Editrice Universitaria Levrotto e Bella, 1974, p 153, 155-187. 10 refs. In Italian.

The lift, thrust and resisting torque of two different kinds of helicopter rotors, one with rigid blades and one with semi-rigid flapping blades (with and without the effect of compressibility) are studied in detail. The notion of the characteristic section of a helicopter blade is introduced and the velocity increase at the rotor disk is viewed as being constant at every point and equal to half of the velocity increase at infinity downstream. An approximation assuming a nonuniform velocity distribution is developed and the relationship between velocity increase at the rotor and that at infinity downstream is determined by means of a kinetic energy theorem. B.J.

A76-30653 Wing profiles in an incompressible fluid in the presence of rigid or fluid walls (Profilu alari in corrente incompressibile in presenza di pareti rigide o fluide). A. Muggia (Torino,

Politecnico, Turin, Italy) In In honor of Carlo Ferrari
Turin, Libreria Editrice Universitaria Levrotto e Bella,
1974, p 549, 551-563 In Italian

A method is developed for finding the velocity field around a thin airfoil of slight curvature swept by an incompressible stream, in the presence of rigid or fluid walls Cases considered include a single rigid plane wall (ground effect) encompassing high incidence angle, two parallel walls (rigid or fluid) The stream is assumed to impinge on the entire airfoil The small perturbations approximation is not applied since large perturbations are in question Exact boundary conditions are carried over to an approximate boundary (double-segment profile, straight walls) The problem is viewed as applicable to studies of tunnel-wall interference, ground effect, and restricted streams (jets)
R D V

A76-30656 Transonic flows past wing profiles A new direct hodograph method S Nocilla, G Geymonat (Torino, Politecnico, Turin, Italy), and B Gabutti (CNR, Laboratorio di Analisi Numerica, Pavia, Italy) In In honor of Carlo Ferrari
Turin, Libreria Editrice Universitaria Levrotto e Bella,
1974, p 589, 591-608 12 refs

A direct procedure on the hodograph plane is developed for determining continuous transonic flow past airfoils, and non-existence theorems denying the generality of smooth transonic flows are examined The existence and stability of transonic shock-free flow past a convex wall is also examined A boundary value problem with a free boundary on the hodograph plane is examined at the outset, with flow irrotational, inviscid, and shock-free A 'strong transonic approximation' is formulated, indicating that results on the physical plane conforming to transonic similitude are affected by the same type of error as results obtained in the hodograph plane inverse problem It is concluded that the problem of calculating continuous transonic flow past an airfoil, with asymptotic Mach number slightly higher than critical, is well posed on the hodograph plane if the curvature is smooth and a free-boundary boundary-value problem is posed
R D V

A76-30704 Advanced fighter program stress shifts W C Wetmore *Aviation Week and Space Technology*, vol 104, May 3, 1976, p 89, 91, 95(3 ff)

Combat versatility of the vectored lift fighter (VLF) is discussed, with diagrams A shift toward use of existing aircraft as test beds (backed up by wind tunnel studies, analytical and flight simulation studies) is noted The variable incidence wing of the VLF cannot be tailored to existing aircraft The six control surfaces (twin vertical stabilizers, beavertail elevator, outboard variable-incidence wing sections, vertical chin fin) offer six degrees of freedom in flight This, plus advantages accruing from digital fly by wire controls plus an analog reversion mode, and relaxed longitudinal static stability margins, enhance VLF performance with such options as fuselage aiming, direct lift, direct side force (particularly useful for roll free landing in crosswinds), thrust modulation and drag modulation in velocity control Drag modulation via symmetric movements of the variable-incidence wings can cause an opponent aircraft attacking the VLF tail to overshoot, losing the combat advantage to the VLF VLF combat advantages, confirmed in flight combat simulation tests, are listed separately
R D V

A76-30750 The new 'Mercure 200' (Le nouveau 'Mercure 200') J Morisset *Air et Cosmos*, vol 14, Apr 24, 1976, p 27 31 In French

The new Mercure 200, an enlarged version of the Mercure 100 equipped with twin CFM56 engines, was cooperatively developed by Dassault Breguet and McDonnell Douglas by optimizing and developing studies carried out for the original Mercure 100 The aerodynamics of the airfoil was refined, the take off weight was increased, and the fuselage was lengthened to provide seating for 27 more passengers than could be accommodated by the original Mercure 100 The integrated engine nacelles were replaced by

nacelles suspended under the wing These modifications are discussed in detail, and the characteristics of the aircraft are presented C K D

A76-30857 # Aerodynamic characteristics of slender wings with sharp leading edges A review A G Parker (Texas A & M University, College Station, Tex) *Journal of Aircraft*, vol 13, Mar 1976, p 161 168 50 refs Contract No N00014-68-A-0308-007

This paper presents an overview of the current state-of-the-art regarding slender wings with sharp leading edges, i.e., wings characterized by the presence of leading edge separation at most angles of attack Several theoretical methods are discussed in detail and their results are compared with experimental data Both steady and some unsteady flows are considered No one theory adequately predicts all aspects of the flow process, and more work is needed, particularly in the fields of vortex control and unsteady flow (Author)

A76-30859 # Optimal trajectories of high-thrust aircraft G M Anderson (USAF, Institute of Technology, Wright Patterson AFB, Ohio) and W L Othling, Jr (USAF, Aeronautical Systems Div., Wright Patterson AFB, Ohio) *Journal of Aircraft*, vol 13, Mar 1976, p 180 184

Future fighter aircraft may have sufficient thrust to sustain maximum turn-rate flight at the corner velocity where the limits on the maximum lift coefficient and maximum normal acceleration load factor are met simultaneously Unfortunately, the usual necessary optimal control conditions break down on these corner velocity arcs This paper presents a set of necessary optimality conditions which must hold when corner velocity arcs are part of an optimal aircraft trajectory First, these necessary conditions are obtained for a general class of problems with two state dependent control variable inequality constraints The resulting conditions are identical to those for optimal control problems with state variable inequality constraints These necessary conditions then are applied to optimal trajectory problems with high thrust aircraft Two sample solutions to the problem of minimum time to turn through a specified heading angle are presented to illustrate some of the features of optimal trajectories with sustained maximum turn-rate corner velocity arcs (Author)

A76-30861 * # Near-hover control of a helicopter with a hanging load N K Gupta (Systems Control, Inc., Palo Alto, Calif) and A E Bryson, Jr (Stanford University, Stanford, Calif) *Journal of Aircraft*, vol 13, Mar 1976, p 217-222 18 refs Contract No NAS2 5143

Piloting a helicopter with a hanging load is a difficult task, especially when the mass of the load is a significant fraction of the mass of the vehicle and there are gusty winds An autopilot logic is proposed here for controlling the helicopter in this configuration and for precision hover It is proposed that the vehicle position be measured using a lightweight cable from the helicopter to a point on the ground near the desired hover point Simulation with one version of S-61 Sikorsky helicopter shows satisfactory controller performance under both design conditions and for parameter changes from one mission to another Assuming noise-free measurements for feedback is found to be far too optimistic in predicting performance, the sensor/estimator design is a key element in the controller (Author)

A76-30862 # Preliminary wind tunnel tests of a finite aspect ratio high performance general aviation wing R K Rice (Cessna Aircraft Co., Wichita, Kan) and R B Oetting (Missouri, University, Rolla, Mo) *Journal of Aircraft*, vol 13, Mar 1976, p 223, 224 5 refs

Results are presented for wind tunnel tests directed at evaluating an airfoil equipped with simple Fowler type flap, the GA(W) 1, developed for low-speed flight, in direct comparison with a current general aviation airfoil of the NACA 2412 section The GA(W) 1

airfoil has a 17% maximum thickness to chord ratio with a cruising lift coefficient of 0.40 at low Mach numbers. Optimum flap location to produce maximum lift for a 30-deg flap setting is determined through wind tunnel tests. The wings tested are of rectangular planform with no tip treatment and of the same geometric aspect ratio of 5.1. Experimental findings indicate that installation of the GA(W)-1 airfoil on a light airplane would result in an improvement in both cruise and climb performance. Increase in maximum lift coefficient, based on a 22% reduction in wing area and no change in powerplant size, could mean as much as a 20 mph increase in cruise speed while leaving takeoff and landing distances and the associated airspeeds essentially the same. S D

A76-30886 # Lateral stability of an aircraft and aileron vibrations, with flexural deformability of the wings and control system elasticity taken into account (Stateczność boczna samolotu i drgania lotek z uwzględnieniem odkształcalności giętnej skrzydeł i sprężystości układu sterowania) J. Maryniak and M. Złocka (Warszawa, Politechnika, Warsaw, Poland) *Mechanika Teoretyczna i Stosowana*, vol. 14, no. 1, 1976, p. 63-81. 23 refs. In Polish.

The effect of rigidity and damping in the aileron control system, with attention given to the flexural deformability of the wings, on the lateral stability of an aircraft and on vibrations of the ailerons is examined. The aircraft is treated as a rigid mechanical system with the above characteristics. Aerodynamical moments and forces are without effect on the type and frequency of the wing natural vibrations. The wings comprise a continuous system with an infinite number of degrees of freedom. Equations of motion appear in quasi-coordinates in Boltzmann-Hamel equations for a system with holonomic constraints. Five degrees of freedom are considered: the three degrees of the rigid body (roll, yaw, sideslip) plus antisymmetrical flexible deformation of the wings and elastic displacement of the ailerons. R D V

A76-30894 Aircraft flight effects on high frequency sound emerging from a constant area jet pipe flow. J. R. Jacques (Cambridge University, Cambridge, England) *Journal of Sound and Vibration*, vol. 45, Apr. 22, 1976, p. 569-582. 6 refs.

The radiation of high frequency sound out of a constant-area jet pipe flow is studied by using ray acoustics and classical results for sound transmission at a sharp interface of relative motion. The sound is assumed to be generated by a three-dimensional point source deeply hidden inside the pipe, which is modeled as a set of two semi-infinite parallel rigid plates. The angular range illuminated by a source inside the jet pipe is determined through a purely geometrical analysis. The effect of flight on the directivity pattern of the radiation, the source being assumed to be essentially omnidirectional, is estimated together with that of the multiple reflection process. Major conclusions are that high frequency sound generated far inside a jet illuminates the forward arc when flow is present, that in a supersonic flow all the waves are convected downstream and the forward arc is totally illuminated, and that the angular width of the illuminated zone is dependent on the flight speed. S D

A76-30915 # Aviation skis I (Narty lotnicze I) *Technika Lotnicza i Astronautyczna*, vol. 31, Apr. 1976, p. 5-7. 5 refs. In Polish.

Brief review article based on foreign sources. Basic aspects of static and dynamic friction, and complications in motion on a snow surface (history of snow cover, exposure to wind, sun, frost, parameters of snow cover), are reviewed. The effect of the fineness ratio and aspect ratio of the skis, limits on unit load, positioning of the ski suspension axis, ways of preventing ski skids sideways, and other ski/snow parameters are considered. The microscopic ski/snow contact pattern is examined, with attention to self-lubrication of ice crystals against steel or Mg alloy, and the theory of melting under pressure. Teflon-lined skis offer the lowest static friction coefficient; friction and sticking must be minimized beyond the point where the

skiplane would have to shake itself free of snow crust before taxiing off. The supersonic bow wave generated by forward-moving skis and proper bow shape (rounded rectangular, not tapered to dig into snow) and wheel-in-ski designs are discussed. R D V

A76-30916 # Technical progress in the design of aircraft from the standpoint of fuel economy (Postęp techniczny w budowie samolotów w aspekcie oszczędności paliwowych) J. Staszek *Technika Lotnicza i Astronautyczna*, vol. 31, Apr. 1976, p. 19-22. In Polish.

Reliance on supercritical airfoil profiles, vortex diffusers, boundary layer suction, active control (of control surfaces), and new materials to reduce the size and weight of passenger airliners and cargo aircraft without penalties in performance is reviewed. Supercritical profiles bring about greater L/D ratios which, with increased wing span, are more effective in reducing induced drag than is the use of vortex diffusers. But vortex diffusers mean a smaller moment arm at the wing root, and only 0.5% increase in bending moment as against 8.5% caused by increased wing span. Boundary layer control through air suction by slits add up to 30% fuel savings. Properly selected flexible elastic BLC coating can reduce drag friction by 50%. Active control of control surfaces means less static stability, but greater indifference to gusts and flutter. Fiber (glass, boron, graphite) reinforced materials (resins, metals) add strength while reducing weight. Fuel savings up to 35% are predicted for the next generation of airliners, and as much as 55% for the next generation of cargo aircraft. R D V

A76-30917 # Problems in pinpointing and eliminating malfunctions in aviation equipment (Problemy lokalizacji i usuwania usterek sprzętu lotniczego) A. Słodownik *Technika Lotnicza i Astronautyczna*, vol. 31, Apr. 1976, p. 27-29. In Polish.

The American FEF1-TAF1 fault location and elimination system for rapid checkout of DC-10 airliners between flights is described in some detail and recommended for efficient flight operations. The goal of 30 minutes turnaround time between flights with rapid and reliable checkout, spotting, and elimination of faults and malfunctions in equipment, at low cost and/or cost compensated by savings through checkout efficiency and prompt correction or replacement of faulty components or systems, is emphasized. The FEF1-TAF1 logic decision chain, with coding of defects and malfunctions and rapid semiautomatic checkout capability, is described for the air conditioning and electric equipment cooling systems. Direct and indirect factors in effective cost cutting in fault detection and elimination are listed. R D V

A76-30950 # The aerodynamics of the Tu-134A (Aerodynamika samolotu Tu-134A) T. I. Ligum (Moscow, Izdatel'stvo Transport, 1975. 320 p. 14 refs. In Russian).

The aerodynamical characteristics of the Tu-134A airframe are discussed, together with the structure and function of its power plant. The different phases of the flight regime, including takeoff, cruise, and landing approach are examined in detail. The behavior and stability of the aircraft at high angles of attack and under unusual flight conditions (abbreviated landing approach, high atmospheric turbulence, engine failure, failure of the stabilizer control system) are analyzed. C K D

A76-31017 # Stability and controllability of an airplane (Ustoichivost' i upravliaemost' samoleta) I. M. Pashkovskii (Moscow, Izdatel'stvo Mashinostroenie, 1975. 328 p. 117 refs. In Russian).

An attempt is made to systematize the domestic and foreign experience concerning the dynamics and controllability of several generations of high-speed jet aircraft. The physical fundamentals of modern stability and controllability theory are outlined, along with new phenomena in this field. Critical situations arising from faults in aircraft design or from malfunctions of onboard systems and devices are examined, along with critical situations that arise when operational safety margins are substantially exceeded. Particular attention

is given to methodological aspects of assessing the controllability and dynamic properties of modern aircraft in flight tests V P

A76-31019 # Aerodynamic derivatives of an aircraft and wing at subsonic speeds (Aerodinamicheskie proizvodnye letatel'nogo apparata i kryla pri dozvukovykh skorostiakh) S M Belotserkovskii and B K Skripach Moscow, Izdatel'stvo Nauka, 1975 424 p 62 refs In Russian

The problem of determining the steady and unsteady aerodynamic characteristics of aircraft and their parts at low Strouhal numbers is examined. The theoretical basis of different approaches is given, and the use of computers for the numerical analysis of the airflow around an airframe is discussed. Several examples are given of application of the methods in the design and optimization of different airfoil configurations for subsonic flight. The numerical results are compared with experimental data C K D

A76-31075 , Balancing of a single rotor helicopter (Balansirovka odnovintovogo vertolet) A S Braverman, D M Perlshtein, and S V Lapisova Moscow, Izdatel'stvo Mashinostroyeniye, 1975 176 p 8 refs In Russian

Methods are described which can be used to calculate helicopter longitudinal and lateral balancing that defines the arrangement of the control elements ensuring steady flight conditions. It is shown how the results of balancing calculations can be used to select the overall layout and design parameters of a single rotor helicopter and how the loads acting on the helicopter can be determined from balancing data V P

A76-31090 # Gasdynamic action as applied to combustion chambers of gas turbine engines (Gazodinamicheskoe vozdeistvie primenitel'no k kameram sgoraniya gazoturbinnnykh dvigatelei) I S Varganov (Kievskoe Vysshee Voennoe Aviatzionnoe Inzhenernoie Uchilishche, Kiev, Ukrainian SSR) *Prikladnaya Mekhanika*, vol 12, Feb 1976, p 111-116 8 refs In Russian

Equations are obtained for determining the required air (gas) consumption of blown-in jet when zones of reverse circulation currents develop in main combustion chambers and afterburners in gas turbine engines. Analytical expressions are presented for constructing the shape and size of the zones of reverse circulation currents according to the lines of demarcation between interacting flows. The forward displacement of these lines of demarcation results in a decrease in the length of the flame jet, which makes it possible to reduce the longitudinal dimensions of the combustion chamber S D

A76-31141 # The dynamic stability of rotor-bearings systems (In tema di stabilità dinamica nei sistemi rotore-cuscinetti) S Stecco and P Caravani (Roma, Università, Rome, Italy) In *Associazione Italiana di Meccanica Teorica ed Applicata, National Congress, 2nd, Naples, Italy, October 16-19, 1974, Proceedings Volume 3* Milan, Associazione Italiana di Meccanica Teorica ed Applicata, 1974, p 1-12 24 refs In Italian

The dynamic stability of rotor-bearings systems is examined with particular reference to the Jeffcott model, and the different kinds of instability are classified. A numerical program is presented together with a procedure for finding stability conditions by means of an automatic routine which chooses the most suitable variations of parameters (Author)

A76-31165 # An exact method for the design of airfoil profiles in incompressible flow with a given velocity distribution on the contour (Un metodo esatto per il progetto di profili alari in corrente incompressibile aventi un prestabilito andamento della velocità sul contorno) L Polito (Pisa, Università, Pisa, Italy) In *Associazione Italiana di Meccanica Teorica ed Applicata, National Congress, 2nd, Naples, Italy, October 16-19, 1974, Proceedings*

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Milan, Associazione Italiana di Meccanica Teorica ed Applicata, 1974, p 159-170 9 refs In Italian

An exact method, based upon conformal mapping procedure, to design airfoil sections with given velocity distribution on the contour in incompressible flow is presented. Unlike Lighthill's method, the velocity distribution is prescribed directly as a function of the surface coordinate along the airfoil. The present method is different from ones recently published both in the way initial data is corrected and in the simplicity of the calculation procedure (Author)

A76-31180 * # Flowfield in the plane of symmetry below a delta wing M S Cramer, A R George, and A R Seebass (Cornell University, Ithaca, N Y) *AIAA Journal*, vol 14, Feb 1976, p 212-215 Grants No NGR-33 010-203, No NGR 33-010-057

The flowfield in the plane of symmetry of a thin lifting delta wing with supersonic leading edges is examined for wings with apex angles that are comparable to the Mach angle, as well as for the limiting case of a straight leading edge. For these two cases, a simplified treatment of the interaction between the plane expansion wave emanating from the trailing edge and the three-dimensional bow shock is presented. In the region unaffected by the wing tips, the shock decays inversely with distance from the wing (Author)

A76-31181 # Unsteady motion of airfoils with boundary-layer separation W R Sears (Arizona, University, Tucson, Ariz) *AIAA Journal*, vol 14, Feb 1976, p 216-220 9 refs Grant No AF-AFOSR-76-2954

It is shown that the condition that determines circulation about an airfoil with boundary layers is identical with the usual inviscid-flow condition based on conservation of total circulation and the Kutta-Joukowski condition, in both steady and unsteady flow. This implies interesting relationships between the viscous and inviscid models, namely, between boundary-layer vorticity and bound-vortex strength, viscous-wake vorticity and free-vortex strength, and vortex/vorticity fluxes, in both steady and unsteady flow. The unsteady aerodynamics of airfoils with rounded trailing edges is discussed in this light, and it is concluded that a dual model is needed, involving a boundary-layer calculation over a smooth body to determine circulation, and a vortex-sheet model to determine the perturbed potential flowfield needed in this calculation, as well as forces and moments on the airfoil (Author)

A76-31185 # Free vibration of curved skew panels R S Srinivasan and K Munaswamy (Indian Institute of Technology, Madras, India) *AIAA Journal*, vol 14, Feb 1976, p 243-245 7 refs

One approximate way to analyze wings is to treat them as skew plates. The free vibration of an isotropic curved skew panel supported on shear diaphragms on all edges is analyzed using the higher-order finite strip method and shallow shell theory in oblique coordinates. The frequencies and modal shapes for a rectangular curved panel and a flat skew plate are compared and found to agree well. Convergence of the frequencies of skew plates is studied by taking different numbers of harmonics and also increasing the numbers of strips B J

A76-31187 * # Stability derivatives for bodies of revolution at subsonic speeds D D Liu (Northrop Corp., Hawthorne, Calif.), M F Platzer (U S Naval Postgraduate School, Monterey, Calif.), and S Y Ruo (Lockheed-Georgia Co., Marietta, Ga) *AIAA Journal*, vol 14, Feb 1976, p 247-250 11 refs Research supported by the Lockheed Georgia Independent Research Program, Contract No NAS8-20082

The paper considers a rigid pointed body of revolution in a steady uniform subsonic flow. The body performs harmonic small-amplitude pitching oscillations around its zero angle of attack position. The body is assumed to be smooth and sufficiently slender so that the small perturbation concept can be applied. The basis of the method used, following Revell (1960), is the relation of a

body-fixed perturbation potential to the general velocity potential. Normal force distributions as well as total force and moment coefficients are calculated for parabolic spindles and the numerical results show good agreement between Revell's second order slender body theory and the present theory for the static stability derivatives of the parabolic spindles. B J

A76-31190 # Numerical investigation of leading-edge vortex for low-aspect ratio thin wings C Rehbach (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) *AIAA Journal*, vol 14, Feb 1976, p 253-255 14 refs

Theoretical results obtained by a method of singularities are presented for plane and cambered wings and for wings with curved leading edges exhibiting the leading-edge vortex flow phenomenon. A convergent result was obtained by introducing an iteration cycle that performed a transformation of the wing planform and its vortex sheet, thus enabling one to begin the iteration process with a configuration presenting no leading-edge vortex sheet (all of which was illustrated by a thin uncambered wing of the Concorde type). Analysis was performed on a plane delta wing with a semi apex angle of 15 degrees at an angle of attack of 15 degrees, and on two plane wings with curved leading edges. Numerical results were compared to those of flow visualization. B J

A76-31424 # The Lifting-Body-Airship - A future delivery system for remote area logistics W M Miller, Jr (Aereon Corp., Princeton, N J), W F Putman (Aereon Corp., Princeton University, Princeton, N J), and C D Havill *Canadian Aeronautics and Space Journal*, vol 22, Jan Feb 1976, p 23-29 14 refs

The problem of gaining access to natural resources located in remote or almost inaccessible regions is considered on the basis of three criteria for an optimal solution. It is argued that the Lifting-Body-Airship (LBA) uniquely meets these criteria and can provide 'remote area logistics' for the developing world. Fuel efficiency and productivity are compared for conventional airships and C10L, VTOL, C/STOL, and V/STOL LBAs. It is shown that the STOL LBA is unsurpassed in productivity while the V/STOL LBA is the most energy-efficient vehicle. F G M

A76-31425 # Canadian Air Cushion Vehicle legislation and regulation J Doherty (Ministry of Transport, Air Cushion Div., Ottawa, Canada) (*Canadian Symposium on Air Cushion Technology*, 9th, Ottawa, Canada, Oct 21, 1975) *Canadian Aeronautics and Space Journal*, vol 22, Jan Feb 1976, p 30-35

This paper reviews the current status of Air Cushion Vehicle legislation and regulation in Canada, discussing the work of the Federal Government Interdepartmental Committee on Air Cushion Vehicle Legislation and outlining future regulating aspects, particularly with reference to vehicle certification, standards and procedures, licensing of pilots and maintenance engineers, registration of vehicles, economic licensing, and other regulatory aspects. Both commercial and recreational air cushion vehicles are considered.

(Author)

A76-31492 * Opportunities for development of advanced large cargo aircraft A H Whitehead, Jr (NASA, Langley Research Center, Hampton, Va.) In *Technology for the new horizon*, Proceedings of the Thirteenth Space Congress, Cocoa Beach, Fla., April 7-9, 1976. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1976, p 5-1 to 5-23 36 refs

A critical review of the history, current state of the art, and future prospects for cargo aircraft systems indicates that three of the major advantages of air cargo are rapid delivery, ability to bridge geographical boundaries, and capability to provide a flexible market response. Foreseeable advances in large aircraft development offer even greater profit potential by increasing the payload ton-miles per pound of fuel. Intermodal containers and handling systems and computerized control and billing may be key ingredients. Details of a

NASA program for large aircraft systems technology are outlined, which includes systems studies, research and technology investigations, and determination of the need for critical flight experiments. Innovative advanced technologies and configuration concepts are discussed. Numerous illustrations supplement the text. S D

A76-31580 # Three-dimensional effects in sonic boom theory T P M Hendriks (Delft, Technische Hogeschool, Delft, Netherlands) (*Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Göttingen, West Germany, Apr 1-5, 1975*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol 56, Mar 1976, p T 190-T 192 5 refs

Approximation techniques for calculating sonic booms generated by slender configurations are examined for their validity in the resulting pressure fields. The Whitham-Walkden method (1952, 1958) is found adequate for the far field, and the second-order approximation of characteristic perturbation theory for the mid-field. Best results for the near field however are obtained with the corrected linearized theory, i.e., predictions based on the general linearized theory with correction of the bicharacteristics. Here the flow field is first calculated using linearized theory, then the straight linear bicharacteristics are corrected by integrating the local first-order characteristic direction from the body into the flow field. Slight differences in the dependence domains (tip effects in the expansion fan from the trailing edge) account for the discrepancies. R D V

A76-31581 # Remarks on 'local linearization' in near-sonic subsonic flows past a profile with a break (Anmerkungen zur 'Lokalen Linearisierung' bei schallnahen Unterschallströmungen um Profile mit Konturknick) J T Heynatz (Stuttgart, Universität, Stuttgart, Dornier GmbH, Friedrichshafen, West Germany) (*Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Göttingen, West Germany, Apr 1-5, 1975*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol 56, Mar 1976, p T 192 T 194. In German

Approximation procedures are outlined for the case when the method of local linearization is applied to profile shapes with a break in the near-sonic subsonic region. Results are illustrated for the example of a rhombus profile and are compared with the exact results obtained for pressure coefficients by hodograph theory. P T H

A76-31585 # Effect of the initial value of the variational problem on the geometry and drag coefficient of the optimum-optimum delta wing in supersonic flow (Einfluss der Anfangswerte der Variationsaufgabe auf die Geometrie und den Widerstandsbeiwert des Optimum-optimum Deltaflügels in Überschallströmung) A Nastase (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany) (*Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Göttingen, West Germany, Apr 1-5, 1975*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol 56, Mar 1976, p T 208-T 211 14 refs. In German

The effect of the initial values of the cruise Mach number, of the lift coefficient, the pitching moment, and the thickness ratio on the geometry and drag coefficient of the optimum-optimum swept-back wing is analyzed. (Camber, wing warp, thickness distribution, and dimensionless wing span are all optimized with respect to minimum drag in the case of the optimum-optimum profile.) Separate analyses are undertaken for a thin profile and a symmetric-thick profile. Flow is assumed stationary, isentropic, and frictionless. The drag of a thin delta wing increases with increasing cruise Mach number and with lift while decreasing with increasing pitch moment. The drag of a symmetric-thick delta wing varies inversely with cruise Mach number and thickness ratio. The entire optimization process is carried out on the basis of dimensionless ratios. R D V

A76-31595 # Eigenvalue problems in the calculation of conical paravoids in steady supersonic flow (Eigenwertprobleme bei

der Berechnung konischer Paragleiter in stationärer Überschallströmung B Wagner (Darmstadt, Technische Hochschule, Darmstadt, West Germany) (*Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Göttingen, West Germany, Apr 1-5, 1975*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol 56, Mar 1976, p 237-T 239 7 refs In German

The paper analyzes the behavior of the contour shapes of a flexible conical parawing with keel in supersonic flow. The equilibrium condition and kinematic flow condition under the assumption of small curvature are written in terms of a dimensionless spanwise coordinate, reduced parameters for contour, pressure difference between upper and lower surface, and perturbation velocity, and a constant representing the ratio of dynamic pressure at infinity and the stress resultant of the membrane. Fredholm integral equations of the second kind are derived for the perturbation velocity at the subsonic leading edge and the elliptic region of the supersonic leading edge. Study of the nature of the eigenvalues yields graphs of the shape parameter as a function of the spanwise coordinate for the first several eigenvalues. P T H

A76-31632 European perspectives in the helicopter field (Les perspectives européennes dans le domaine des hélicoptères) F Legrand (Société Nationale Industrielle Aérospatiale, Paris, France) (*Journée Franco-Allemande Otto Lilienthal, 16th, Technische Universität Berlin, Berlin, West Germany*) *L'Aéronautique et l'Astronautique*, no 57, 1976, p 3 18 In French

The economic and technological factors contributing to the large percentage of the world helicopter market accounted for by aircraft produced by European countries are examined. Future trends in the European and world market for helicopters for civil and military applications are considered. The effect on helicopter research and development of decreasing expenditures in military programs and increasing emphasis on light (less than 10 seats) helicopters is discussed. The cooperative Franco-Britannic Lynx, Gazelle, and Puma programs are described, and the prospects of future cooperative programs in research, development and sales in the helicopter field are discussed. C K D

A76-31634 Analog-digital filtering for the determination of steady and variable forces in tunnel testing (Filtrage analogique numérique des efforts stationnaires et des accidents aérodynamiques en soufflerie) F Charpin (ONERA, Modane, Savoie, France) *L'Aéronautique et l'Astronautique*, no 57, 1976, p 33-41 In French

An analog-digital filtering technique has been developed which can be used to obtain the steady aerodynamic coefficients of a wind tunnel model as a function of the continuously variable angle of attack, and to reproduce aerodynamic incidents such as wing dropping and stall. The suggested system of measurement and analysis permits the real-time monitoring of the steady aerodynamic coefficients. Results of vibration tests have shown that when the mechanical response of the model-balance system is sufficiently pure, the system can be modeled by a second order transfer function. This modelisation can be used to reproduce the aerodynamic impulses occurring on the airfoil. C K D

A76-31635 Value analysis - Its application to the economical light helicopter (L'analyse de la valeur - Une application au cas de l'hélicoptère léger économique) J Grandcoing (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Marignane, Bouches du Rhône, France) *L'Aéronautique et l'Astronautique*, no 57, 1976, p 43-49, Discussion, p 50 8 refs In French

The application of value analysis methodology in the development of an economical light helicopter with a high level of reliability is discussed. The use of previously existing technology, simplified designs, and mass produced parts, and heavy reliance on light, 'fail safe' construction materials such as fiberglass have led to

substantial cost and weight savings. The rotor hub and transmission of the economical helicopter are compared with those of the Alouette II and the Gazelle. C K D

A76-31715 Generalized similarity laws in flows past solid bodies A I Bunimovich and A V Dubinskii (*Priladnaia Matematika i Mekhanika*, vol 39, July-Aug 1975, p 739-742) *PMM - Journal of Applied Mathematics and Mechanics*, vol 39, no 4, 1975, p 709-713 5 refs Translation

For the case where the momentum flux at the surface of the body depends essentially on the local angle between the normal to the surface and the direction of the flow (as in case of hypersonic gas flow in a Newtonian formulation, or the flow of a rarefied gas), it is shown how generalized similarity laws can be established which relate the aerodynamic characteristics of three-dimensional affine dissimilar bodies situated in various gas flows (e.g., a Newtonian flow or a free-molecular flow of a rarefied gas). Methods of forming the respective bodies are proposed. The application of the similarity laws is demonstrated by examples. V P

A76-31735 Developments in jet noise modelling - Theoretical predictions and comparisons with measured data B J Tester (Lockheed-Georgia Co., Marietta, Ga.) and C L Morfey (Southampton, University, Southampton, England) *Journal of Sound and Vibration*, vol 46, May 8, 1976, p 79-103 27 refs Contract No F33615-73-C-2032

Spectral information on the sound radiated from turbulent shock-free jets is now available over a wide range of Strouhal numbers, for jet densities ranging from 0.3 to 2 times the ambient density and jet velocities ranging from 0.3 to 2 times the ambient sound speed. In order to account for some of the trends observed, a jet noise model is developed which takes account of acoustic-mean flow interaction. The model is based on a shear flow analogy, for which the governing equation is Lilley's equation, and numerical solutions are obtained for sources representative of turbulent mixing noise. Analytic solutions developed for low- and high-frequency excitation show good agreement with the numerical results. Finally, the model predictions are compared with measurements on hot and isothermal jets. (Author)

A76-31738 Multiplicative signal processing for sound source location on jet engines O E Flynn (Westinghouse Electric Corp., Baltimore, Md.) and R Kinns (Y-ARD, Ltd., Glasgow, Scotland) *Journal of Sound and Vibration*, vol 46, May 8, 1976, p 137-150 9 refs Research supported by Rolls Royce (1971), Ltd

It is known that multiplicative processing of signals from receiver arrays can be used to obtain increased resolution for target identification where the target signal is strong in relation to extraneous noise. There is an analogy between target identification and the location of sound sources in jet engines where the extent of sources is not great on a wavelength scale. A theory for multiplicative processing of signals from two sub-arrays is developed for the case of a line source of generally correlated sound radiators which share the measurable far-field properties of a real jet engine. The real part of the cross spectrum of the sub array signals is used as an estimator of frequency dependent sound source intensity and results are compared with their equivalents for additive processing. The method has been implemented on a minicomputer and used for studies on full size jet engines. Some typical results are presented. (Author)

A76-31802 Airline regulation by the civil aeronautics board E M Kennedy (U.S. Senate, Washington, D.C.) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 607-636

A summary of the final report of the Senate Subcommittee on Administrative Practice and Procedure investigation of the practices and procedures of the Civil Aeronautics Board (CAB) is presented. The subcommittee has concluded that CAB practices are effective in

promoting industry growth, technological improvement, and reasonable industry profits, but have not been effective in maintaining low prices. In addition, some procedures followed in setting route and enforcement policies were judged to lack openness and impartiality. It is recommended that Congress enact legislation designed to limit the power of the CAB to control prices, restrict entry, and confer antitrust immunity. It is suggested a reasonable transition period be allowed for the industry to adjust. C K D

A76-31803 **Aviation regulation - A time for change** J W Snow (US Department of Transportation, Washington, D C) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 637-664 78 refs

The effectiveness of the Civil Aeronautics Board's regulation procedures in allocating resources in response to the needs of the public is examined. The provisions of the Aviation Act of 1975, designed to liberalize entry, increase pricing flexibility, and narrow CAB power to grant antitrust immunity, are reviewed, and their impact on the economic performance of the airline industry is considered. A brief discussion of arguments commonly raised in opposition to modernization of CAB procedures, including the possible development of 'cut-throat competition' and monopolies and reduction of service to small communities, is presented. C K D

A76-31804 **An introduction to regulatory reform for air transportation** D Heymsfeld (US House of Representatives, Washington, D C) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 665-677 10 refs

Basic information is provided on causes of dissatisfaction with the Civil Aeronautics Board (CAB) system of regulation of air transportation. Current CAB procedures in the allocation of markets and regulation of air fares are outlined, and reforms included in the Aviation Act of 1975 are summarized. Issues raised by the preferential status accorded to incumbent airlines by the Act with regards to market entry privileges are discussed, and the ability of present carriers to adjust to deregulation is considered. C K D

A76-31805 **A perspective on airline regulatory reform** J C Miller, III (Executive Office of the President, Washington, D C) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 679-701 39 refs

Arguments are presented in favor of reform of Civil Aeronautics Board regulatory procedures. It is argued that the present 55% of capacity standard in use by the CAB is inconsistent with rising fuel costs and leads to sizeable dead-weight losses to the trunk carriers which are transmitted to the passenger. Experience with intrastate routes indicates that gaps in service created by exits of major carriers can be profitably filled by small airlines. There is no evidence to suggest that safety standards would be adversely affected by deregulation. (Author)

A76-31806 **Alternatives to regulation - Competition in air transportation and the aviation act of 1975** M E Levine *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 703-726 66 refs

The provisions of hypothetical deregulatory legislation reflecting only the current state of empirical knowledge regarding air transport are considered and compared with the Aviation Act of 1975. A literature review indicates that the current system of air transportation regulation has resulted in fares 30-56% higher than those predicted in the absence of regulation, aircraft operating at 2/3 their designed seating capacity with only half of the seats filled, a limited range of service options, suppression of new fare and service combinations, and larger air carriers than are necessary from the standpoint of efficiency. An optimum regime would make maximum use of competition in both domestic and overseas transportation. It is concluded that the advantageous features of the proposed Aviation Act stem from elimination of regulation, while its defects result from failure to eliminate regulatory provisions. C K D

A76-31807 **A comparison of two proposals for regulatory change** L S. Keyes *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 727-745 38 refs

The Aviation Act of 1975 (the Act) is compared with the report of the Civil Aeronautics Board's Special Staff on Regulatory Reform (the Report). With the assumption that section 6(b) of the Act is amended to clarify the definition of a city-pair market to include satellite as well as principal terminals, the major differences in the short-term regulatory programs of the Act and the Report are in the Report's more conservative approach to charter rules, pricing, and intercarrier agreements, and in its recommendation that open entry be promptly initiated in supplemental and all-cargo air transportation. In the long term (3-5 years), the Report recommends a more liberal approach to entry, charters, and maximum price control and a somewhat more stringent approach to the treatment of mergers. The reasons for these differences are discussed, and the economic consequences of both programs are considered. C K D

A76-31808 **Airline deregulation - A hoax** J W Callison (Delta Air Lines, Inc., Atlanta, Ga) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 747-791 107 refs

An attempt is made to establish that the Federal Aviation Act of 1938 provides for the goals of the reforms contained in the Aviation Act of 1975. The history of the Civil Aeronautics Board's application of provisions regarding entry and exit and pricing competition is examined. It is argued that needed reforms can be accomplished by periodic review of the existing statute, extensive new legislation is deemed unnecessary. C K D

A76-31809 **Need for continued economic regulation of air transport** M A Brenner (Trans World Airlines, Inc., New York, N Y) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 793-813 8 refs

It is argued that competitive conditions in the air transportation tend to lead to overcapacity. This is the direct result of a combination of factors which is unique to the supply/demand equation of industry, including the inseparable linkage of production and consumption, with no storage for surplus, the competitive value of schedule frequency, and substantial 'fixed' costs. It is predicted that free price competition would eliminate competition in non-price channels, especially in schedule capacity, only until all carriers have matched the lowered price, with an eventual increase in overcapacity. It is argued that deregulation would have severe detrimental effects on the ability of airlines to raise capital for future progress. C K D

A76-31810 **Deregulation and its potential effect on airline operations** D J Lloyd-Jones (American Airlines, Inc., New York, N Y) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 815-841

The probable effects of partial or total deregulation of the U S air transportation industry are discussed. It is contended that the existing system of air transportation serves the requirements of the public in a manner superior to that of any comparable foreign system. An attempt is made to show that deregulation would be counter-productive, its long-term effect would be increased prices and reduced service to less heavily traveled routes. It is recommended that the modifications to the existing regulatory system suggested by the Air Transport Association be adopted. These include setting reasonably short time limits within which applications and petitions should be heard or dismissed, increasing the flexibility of pricing at the discretion of the airline management, and limiting presidential power to overrule the Civil Aeronautics Board to questions of foreign policy and national defense. C K D

A76-31811 **Deregulation and local airline service - An assessment of risks** R J Rasenberger *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 843-872 47 refs

It is argued that adoption of the Aviation Act of 1975 might result in higher prices, lower quality service, and domination of the air transportation industry by a few large carriers. It is contended that the apparent success of intrastate airlines in offering low fares is due to special characteristics of their markets such as high traffic density and little dependence on flow traffic. It is suggested that separate regulatory policy be developed for large independent

markets which is consistent with a national system of many interdependent markets C K D

A76-31812 **Deregulation, the adjustment process** W L Demory (Civil Aeronautics Board, Washington, D C) *Journal of Air Law and Commerce*, vol 41, Autumn 1975, p 873-883 12 refs

The short-term process of adjustment to the elimination of price and entry control in the air transportation industry is examined using static equilibrium models It is predicted that fares and service may temporarily reach unprofitable levels in some markets until a new equilibrium point is attained The existing network should be maintained, since the vast majority of city pairs are economically viable Certificated carriers may be expected to have an advantage during the adjustment period due to an established route network, market identity, and a history of service Empirical evidence from England and Australia, where the trucking industry was abruptly deregulated, indicates that no severe instability would occur C K D

A76-31867 # **Techniques for automated design** D W Kelly, R O Stafford (Imperial College of Science and Technology, London, England), A J Morris, and P Bartholomew (Royal Aircraft Establishment, Farnborough, Hants, England) In Post Conference on Computational Aspects of the Finite Element Method, 3rd, London, England, September 8, 9, 1975, Proceedings

London, Imperial College of Science and Technology, 1975, p 213-248 30 refs

The paper explores the possibility of the Lagrangian function as a unified basis for relating modern automated design procedures The design problem is formulated as the search for the stationary point of a Lagrangian function This point is shown to be a saddle point representing the point of convergence of two problems, one requiring a minimization process and the other a maximization process, which are the primal and dual problems commonly encountered in optimization techniques The optimality criterion methods to design for specific strength or stiffness requirements are developed from the Lagrangian, and mathematical programming procedures for dealing with constrained problems are shown to base their search strategies either directly or indirectly on the Lagrangian form Methods are proposed which use the properties of the Lagrangian saddle point for checking convergence and draw on certain aspects of mathematical programming to guide simple redesign strategies when they fail to achieve the optimum design A final section considers the merits and economies of automating the redesign process and the software development which is necessary to interface these procedures with standard finite element systems P T H

A76-31922 # **A study of two-dimensional accelerative cascades - An investigation on the optimum blading and the velocity distribution along the upper surface of blade** K Teshima (Mitsui Shipbuilding and Engineering Co, Ltd, Tamano, Japan) *JSME, Bulletin*, vol 19, Mar 1976, p 291-297

This report deals with the problem of optimum blading such as designing the profiles and bladings in turbine cascades to minimize the blade loss for various loading conditions For this purpose forty cases of cascades, different in blade arrangement and inlet and outlet flow conditions, were examined with the aid of boundary layer theory The parameters for the optimum blading were the frictional loss coefficient, diffusion factor of the upper surface, pitch-chord ratio and the value of maximum velocity and its location As a result, some conditions necessary for the optimum blading were made clear, and a new parameter representing the loss coefficient was introduced Furthermore, the agreement of these results about the optimum pitch-chord ratio with those of conventional methods was fairly good (Author)

STAR ENTRIES

N76-22151 Johns Hopkins Univ Baltimore, Md
UNSTEADY RESPONSE OF AN AIRFOIL TO WAKE CUTTING Ph D Thesis

Hajime Fujita 1972 140 p
 Avail Univ Microfilms Order No 76-8486

An experimental study of a transient interaction between an airfoil and passing wake, commonly known as 'wake cutting,' was carried out in order to contribute to basic understanding of interaction problems between successive blade rows in turbomachinery. An open jet (30 cm square orifice, 38 m/s nominal velocity) was cut periodically by moving circular rods (1 cm diameter) in pin-wheel fashion and a periodic moving row of wakes was produced. A circular arc symmetric airfoil equipped internally with a pressure transducer was placed in the jet. In order to extract the periodic component of the signals by suppressing the random turbulent signal a special processing technique was employed. Dissert Abstr

N76-22152 Michigan Univ, Ann Arbor
STALLED AND PARTIALLY STALLED HIGH ASPECT RATIO, STRAIGHT WINGS Ph D Thesis

Earl Floyd Weener 1975 234 p
 Avail Univ Microfilms Order No 76-9541

A computer investigation of the steady state load distribution on high aspect ratio, straight wings at geometric angles of attack near and beyond stall was conducted. The load distributions were computed using Multhopp's Fourier series solution of the downwash integral in Prandtl's lifting line theory. Analog computer solutions at high angles of attack exhibited sharp changes or jumps of the variables which were due to instabilities of the nonlinear system. The stability properties were examined via linearized equations written about singular operating points of the nonlinear system. For a specific wing model stability is shown explicitly in terms of the slopes of the local airfoil characteristics. Dissert Abstr

N76-22154* National Aeronautics and Space Administration
 Langley Research Center Langley Station Va
AIRFOIL SHAPE FOR FLIGHT AT SUBSONIC SPEEDS Patent

Richard T Whitcomb, inventor (to NASA) Issued 27 Apr 1976
 14 p Filed 9 Nov 1971 Supersedes N73-14981 (11 - 06, p 0613)
 (NASA-Case-LAR-10585-1 US-Patent-3,952 971
 US-Patent-Appl-SN-197183, US-Patent-Class-244-35R
 US-Patent-Class-244-40R) Avail US Patent Office CSCI 01A

An airfoil is examined that has an upper surface shaped to control flow accelerations and pressure distribution over the upper surface and to prevent separation of the boundary layer due to shock wave formulation at high subsonic speeds well above the critical Mach number. A highly cambered trailing edge section improves overall airfoil lifting efficiency. Diagrams illustrating supersonic flow and shock waves over the airfoil are shown.

Official Gazette of the U S Patent Office

N76-22156* National Aeronautics and Space Administration
 Lewis Research Center, Cleveland Ohio
EFFECTS OF PERFORATED FLAP SURFACES AND

SCREENS ON ACOUSTICS OF A LARGE EXTERNALLY BLOWN FLAP MODEL

Robert J Burns Daniel J McKinzie Jr, and Jack M Wagner
 Washington Apr 1976 41 p refs
 (NASA-TM-X-3335 E-8559) Avail NTIS HC \$4 00 CSCI 01A

Various model geometries and combinations of perforated flap surfaces and screens mounted close to the flap surfaces were studied for application to jet-flap noise attenuation for externally blown flap under-the-wing aircraft. The efforts to reduce jet-flap interaction noise were marginally successful. Maximum attenuations of less than 4 db in overall sound pressure level were obtained in the flyover plane. Noise reductions obtained in the low-to-middle-frequency ranges (up to 7 db) were generally offset by large increases in high-frequency noise (up to 20 db). Author

N76-22157* Scientific Translation Service Santa Barbara Calif
RIGOROUS METHOD FOR THE DETERMINATION OF THE MEAN CAMBER LINE FOR PROFILES OF UNKNOWN CAMBER

K Bausch Washington NASA Apr 1976 17 p Transl into ENGLISH from Techn Berichte (West Ger) v 11 1944 p 11-16
 (Contract NASw-2791)
 (NASA-TT-F-17004) Avail NTIS HC \$3 50 CSCI 01A

The rigorous solution of the problem of finding the camber line for an arbitrary lifting profile with unknown curvature leads to an ordinary differential equation of the first order. Using known graphical and numerical solution methods the camber line can be found rapidly as the integral curve of the differential equation. Author

N76-22159* National Aeronautics and Space Administration
 Langley Research Center Langley Station Va
COMPARISON OF SUPERCRITICAL AND CONVENTIONAL WING FLUTTER CHARACTERISTICS

Moses G Farmer Perry W Hanson and Eleanor C Wynne May 1976 9 p refs Presented at the AIAA/ASME/SAE 17th Struct, Structural Dyn and Mater Conf Valley Forge Pa, 5-7 May 1976
 (NASA-TM-X-72837) Avail NTIS HC \$3 50 CSCI 01A

A wind-tunnel study was undertaken to directly compare the measured flutter boundaries of two dynamically similar aeroelastic models which had the same planform, maximum thickness-to-chord ratio and as nearly identical stiffness and mass distributions as possible with one wing having a supercritical airfoil and the other a conventional airfoil. The considerations and problems associated with flutter testing supercritical wing models at or near design lift coefficients are discussed and the measured transonic boundaries of the two wings are compared with boundaries calculated with a subsonic lifting surface theory. Author

N76-22166* Messerschmitt-Boelkow-Blohm G m b H Otto-brunn (West Germany) Unternehmensbereich Flugzeuge
THEORETICAL AND NUMERICAL INVESTIGATIONS ON THE AERODYNAMICS OF A YAWING WING-BODY-TAIL CONFIGURATION (AIRBUS) Thesis - Tech Univ Munich

Ulrich Klaus 19 Jun 1974 159 p refs In GERMAN ENGLISH summary

(MBB-UFE-1164-O) Avail NTIS HC \$6 75
 The MBB panel method was used to calculate the pressure distribution for an Airbus A300 B2 type wing-body-tail configuration for straight and yawing flight. The following items were investigated: lift distribution on wing fuselage and vertical tail with special regard to the interference in straight and yawing flight and rolling moment of the wing-body-vertical tail combination. Effects of sweep and vee shape as well as the vertical tail are discussed. ESA

N76-22167* National Aerospace Lab Amsterdam (Netherlands)
 Flight Dynamics Div

MEASUREMENTS OF THE REYNOLDS STRESS TENSOR IN A THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER UNDER INFINITE SWEEP WING CONDITIONS

A Elsenaar and S H Boelsma 3 Jul 1974 114 p refs
(NLR-TR-74095-U) Avail NTIS HC \$5 50

Measurements were made on a wind tunnel model of the six components of the Reynolds stress tensor in a three-dimensional incompressible turbulent boundary layer under infinite swept wing conditions in an adverse pressure gradient with a three-dimensional separation near the trailing edge. These measurements complement the mean velocity measurements that were carried out earlier in the same test set-up. The measurements were carried out with a rotatable X-wire probe. An extensive discussion of the errors involved in this type of measurement is given. Turbulence intensities and turbulent shear stresses were measured. From the mean velocity profiles the velocity gradient was derived and compared with the shear stress magnitude and direction. An interpretation of the results is included.

Author (ESA)

N76-22168# Aeronautical Research Inst of Sweden Stockholm Aerodynamics Dept

TWO-DIMENSIONAL WIND TUNNEL EXPERIMENTS WITH SINGLE AND DOUBLE SLOTTED FLAPS Final Report

Bjoern L G Ljungstrom Oct 1975 70 p refs
(Contract STU-73-4381)

(FFA-TN-AU-1083) Avail NTIS HC \$4 50

Experiments were carried out with a two-dimensional high lift wing based on a NACA 65 sub 2-215 profile. Five different configurations were optimized including one single slotted flap and two different double slotted flaps with a relatively large first element. The best maximum lift results are 4.28 for a single slotted flap (with leading edge slat) and 4.8 for both the alternative double slotted flaps (with leading edge slat). Results were compared with those of earlier tests with the same model. The double slotted flaps with larger first elements appear to have better drag characteristics (higher maximum L/D) than the more conventional vane type flaps. The maximum lift coefficient is however slightly lower (4.8 compared to 5.0). Slat efficiency is shown to increase with increasing trailing edge flap angle and complexity. An attempt was made to study the effect of Reynolds number in the range from 1.83 to 2.23 x 1 million. Further investigations of Reynolds number effects in a pressurized tunnel are recommended.

Author (ESA)

N76-22169# Imperial Coll of Science and Technology London (England) Dept of Aeronautics

A NUMERICAL SIMULATION OF THE RAREFIED HYPERSONIC FLAT PLATE PROBLEM

D I Pullin and J K Harvey Sep 1975 41 p refs
(Contract SRC-B/RG/4313)

(IC-Aero-75-08) Avail NTIS HC \$4 00

The direct simulation Monte-Carlo method for the full Boltzmann equation is applied to the problem of rarefied hypersonic flow of rotationally excited N₂ past the leading edge of a two-dimensional flat plate aligned with the free stream. An approximate collision model representing rotational-translational energy exchanges is developed for use in the calculations. The effects of this and other inelastic collision models and of the single parameter Maxwell gas-surface interaction law on the flow in the kinetic/transition regime is discussed.

Author (ESA)

N76-22170# Bristol Univ (England) Dept of Aeronautical Engineering

THE THREE SHOCK CONFLUENCE PROBLEM FOR THE CASE OF NORMALLY IMPINGING OVEREXPANDED JETS

Gautam T Kalghatgi and B L Hunt [1974] 90 p refs
(BLH/7402 PG/GTK/7402) Avail NTIS HC \$5 00

A systematic account of the triple shock intersection problem covering all possible types of triple shock intersections has been presented. This problem has been studied in the particular context of the triple shock intersection arising due to the normal impingement of an overexpanded jet issuing from a contoured nozzle. A detailed discussion of the interesting cases where supersonic flow exists on one side of the slipstream at the

triple shock intersection point is included. The cases where a thermodynamically possible analytic solution is either non-existent or physically impossible are discussed. For cases where more than one thermodynamically possible analytical solution exist a quantitative discussion which takes into consideration non-homentropic effects is presented to establish the physical possibility of these solutions. The possibility that for some cases the shock curvatures at the triple point might tend to infinity and invalidate the classical solution of the triple shock problem is considered. The knowledge of the conditions at the triple point has been used along with the boundary conditions for the normal impingement problem to construct qualitative flow pictures for contoured nozzles operating at all possible combinations of exit Mach number and degree of overexpansion. Finally some experimental evidence in the form of schlieren pictures is presented. This evidence though by no means conclusive supports the theory.

Author (ESA)

N76-22172# European Space Agency Paris (France)

EXPERIMENTAL INVESTIGATION OF JET FLOW OVER AN AIRFOIL (COANDA EFFECT)

Hansgeorg Riedel Dec 1975 73 p refs Transl into ENGLISH of 'Exptl Untersuchung der Strahlstromung ueber ein Tragfluegelprofil (Coanda-Effekt)', DFVLR Porz West Ger Report DLR-FB-73-98, 8 Aug 1973. Original German report available from DFVLR, Porz West Ger DM 29 50.

(ESA-TT-234 DLR-FB-73-98) Avail NTIS HC \$4 50

The properties and the behavior of the flow of a quasi two-dimensional jet over a curved surface were investigated with reference to an RAE 100 airfoil of 25 % thickness-chord ratio. For the case of a turbulent jet of air discharged into the free atmosphere in the vicinity of the airfoil main attention centered on the determination of the separation-flow reattachment characteristics of the airfoil as well as the distribution of total and static pressure and of velocity in the flow field surrounding the airfoil.

Author (ESA)

N76-22173# European Space Agency Paris (France)

THE EFFECTS OF GEOMETRIC PARAMETERS ON STATIC PRESSURE MEASUREMENTS IN A RAREFIED HYPERSONIC FLOW

K Kienappel Feb 1976 106 p refs Transl into ENGLISH of 'Der Einfluss geometrischer Parameter auf die Messung des statischen Druckes in verduennter Hyperschallstromung', DFVLR, Goettingen, West Ger Report DLR-FB-73-41 1973. Original German report available from DFVLR, Porz West Ger DM 36 90.

(ESA-TT-266, DLR-FB-73-41) Avail NTIS HC \$5 50

The influence of the inclination and the diameter to length ratio of a pressure tap on the observed pressure was investigated experimentally in a rarefied hypersonic flow. The experiments were carried out on slender and blunt bodies utilizing the 2nd test section of a vacuum tunnel. The results were used to develop an empirical procedure for estimating the geometric effects on slender body pressure measurements.

Author (ESA)

N76-22174# Committee on Interstate and Foreign Commerce (U S House)

INTERNATIONAL AIR TRANSPORTATION COMPETITION

Washington GPO 1974 456 p refs Hearings on HR 14266 HR 13824 HR 14355 HR 14394 HR 14627 HR 14970 and H Res 1405 before Comm on Interstate and Foreign Commerce and the Subcomm on Transportation and Aeron 93d Congr, 2d Sess 25-26 Jun, 10-11 Jul, and 9 Oct 1974.

(GPO-37-626) Avail Comm on Interstate and Foreign Commerce

Amendments to the Federal Aviation Act which deal with discriminatory and unfair practices in international air transportation and provide financial assistance during the energy crisis to U S air carriers engaged in overseas and foreign air transportation are discussed. Alternatives to a fuel subsidy are considered. These include positive revenue impact of a fare increase potential.

downward effect on fuel prices of a proposed Federal Energy Office rule requiring increased refining of jet fuel and its price-controlled allocation to the international airlines possible consolidation of North Atlantic service by Pan Am and TWA and granting of new route authority by the CAB J M S

N76-22175*# Bell Helicopter Co Fort Worth Tex
CONCEPTUAL DESIGN STUDY OF 1985 COMMERCIAL TILT ROTOR TRANSPORTS VOLUME 3 STOL DESIGN SUMMARY Final Report

K W Sambell Washington Apr 1976 97 p refs 4 Vol
 (Contract NAS2-8259)
 (NASA-CR-2690, D313-099-001-Vol-3) Avail NTIS
 HC \$5 00 CSCL 01C

A conceptual design study is presented of 1985 commercial tilt rotor STOL transports for a NASA 200 n mi (370 km) STOL Mission A 100-passenger STOL Variant (Bell D313) of the Phase I VTOL Tilt Rotor Aircraft is defined Aircraft characteristics are given with the aircraft redesigned to meet 2,000-foot (610 m) field criteria with emphasis on low fuel consumption and low direct operating cost The 100-passenger STOL Tilt Rotor Aircraft was analyzed for performance, weights, economics handling qualities noise footprint and aeroelastic stability Author

N76-22176# European Space Agency Paris (France)
CONTRIBUTION TO ROUTING AIRCRAFT AND TO THE ECONOMY OF AIR TRANSPORTATION

Hanns-Juergen Peters Dec 1975 121 p refs Transl into ENGLISH of Beitr zum Netzumlauf von Flugzeugen u zur Wirtschaftlichkeit des Flugbetriebs DFVLR, Stuttgart Report DLR-FB-74-25 1974 Original German report available from DFVLR Porz, West Ger DM 45
 (ESA-TT-222 DLR-FB-74-25) Avail NTIS HC \$5 50

The cost estimation was separated from establishing aircraft rotation within an airline network An effective procedure for routing aircraft is given based on well known methods of operations research The economics of aircraft operation is determined by applying Lufthansa and Lockheed methods An equivalent interaction of both aspects of aircraft operation causes improved efficiency of air transportation A proposed solution is applied to a regional airline system model yielding quantitative results Author (ESA)

N76-22177# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany)
 Zentralabteilung Luftfahrttechnik

AIRWORTHINESS AND SAFETY REGULATIONS FOR CIVIL AND MILITARY AIRCRAFT IN PARTICULAR FOR VSTOL AND STOL AIRCRAFT [ZIVILE UND MILITAERISCHE LUFTTUECHTIGKEITS- UND SICHERHEITS-VORSCHRIFTEN, IM BESONDEREN FUER VSTOL- UND STOL-FLUGZEUGE]

K Wagner Feb 1974 37 p refs In GERMAN
 (DLR-IB-555-74/1) Avail NTIS HC \$4 00

Regulations for aircraft in general and Powered Lift Aircraft (PLA) in particular are reviewed The concepts of quality assurance and airworthiness are discussed as well as airworthiness regulations and recommendations of PLA with particular reference to US-MIL-SPEC Airworthiness recommendations and/or considerations for PLA - VSTOL and STOL - for in-flight operations are dealt with A literature review is given ESA

N76-22178# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany)
 Zentralabteilung Luftfahrttechnik

RELATIONS BETWEEN SAFETY, RELIABILITY, MAINTENANCE, AND MAINTAINABILITY [ZU DEN VERKNUEPFUNGEN VON SICHERHEIT, ZUVERLAESSIGKEIT, INSTANDHALTUNG UND INSTANDHALTBARKEIT]

K Wagner Nov 1974 11 p refs In GERMAN
 (DLR-IB-555-74/7) Avail NTIS HC \$3 50

The interdependence of various features of equipment is outlined Topics dealt with briefly are relationships between safety and reliability, relationships between maintenance and safety and reliability and, finally, the relationships with maintainability It is

concluded that the design engineer and manufacturer should take the abovementioned factors into consideration in designing equipment An example is given for an aircraft with an engine failure ESA

N76-22179*# Analytical Mechanics Associates Inc Jericho NY

SIMULATION, GUIDANCE AND NAVIGATION OF THE B-737 FOR ROLLOUT AND TURNOFF USING MLS MEASUREMENTS

S Pines, S F Schmidt and F Mann 8 Dec 1975 68 p refs

(Contract NAS1-13746)
 (NASA-CR-144959 AMA-75-40) Avail NTIS HC \$4 50 CSCL 17G

A simulation program is described for the B-737 aircraft in landing approach a touchdown rollout and turnoff for normal and CAT III weather conditions Preliminary results indicate that microwave landing systems can be used in place of instrument landing systems landing aids and that a single magnetic cable can be used for automated rollout and turnoff Recommendations are made for further refinement of the model and additional testing to finalize a set of guidance laws for rollout and turnoff Author

N76-22180*# National Aeronautics and Space Administration Langley Research Center Langley Station Va

RELATIVE EFFECTIVENESS OF SEVERAL SIMULATED JET ENGINE NOISE SPECTRAL TREATMENTS IN REDUCING ANNOYANCE IN A TV-VIEWING SITUATION

Walter J Gunn Tsuyoshi Shigehisa and William T Shepherd (FAA Washington D C) Apr 1976 47 p refs
 (NASA-TM-X-72828) Avail NTIS HC \$4 00 CSCL 05E

An experiment was conducted in order to determine the relative effectiveness of several hypothetical jet engine noise treatments and to test hypothesis that speech interference at least in part mediates annoyance in a TV-viewing situation Twenty-four subjects watched television in a simulated living room Recorded jet flyover noises were presented in such a way as to create the illusion that aircraft were actually flying overhead There were 27 stimuli (nine spectra at three overall levels) presented at an average rate of approximately one flight every 2 minutes Subjects judged the annoyance value of individual stimuli using either a category rating method or magnitude estimation method in each of two 1-hour sessions The spectral treatments most effective in reducing annoyance were at 16 Khz and 800 Hz in that order The degree of annoyance reduction resulting from all treatments was affected by the overall sound level of the stimuli with the greatest reduction at the intermediate overall sound level about 88 to 89 db(A) peak value The results are interpreted as supporting the hypothesis that speech interference at least in part mediates annoyance with aircraft noise in a TV-viewing situation Author

N76-22185*# Mississippi State Univ Mississippi State Dept of Aerophysics and Aerospace Engineering

FLIGHT TEST EVALUATION OF A METHOD TO DETERMINE THE LEVEL FLIGHT PERFORMANCE PROPELLER-DRIVEN AIRCRAFT Semiannual Progress Report, Oct - Mar 1976

Ernest J Cross Jr Mar 1976 58 p
 (Grant NSG-1231)

(NASA-CR-147092) Avail NTIS HC \$4 50 CSCL 01C

A procedure is developed for deriving the level flight drag and propulsive efficiency of propeller-driven aircraft This is a method in which the overall drag of the aircraft is expressed in terms of the measured increment of power required to overcome a corresponding known increment of drag The aircraft is flown in unaccelerated straight and level flight and thus includes the effects of the propeller drag and slipstream Propeller efficiency and airplane drag are computed on the basis of data obtained during flight test and do not rely on the analytical calculations of inadequate theory Author

N76-22186*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

TRANSONIC LATERAL AND LONGITUDINAL CONTROL CHARACTERISTICS OF AN F-8 AIRPLANE MODEL EQUIPPED WITH AN OBLIQUE WING

Ronald C Smith Robert T Jones and James L Summers Mar 1976 295 p refs
(NASA-TM-X-73103 A-6434) Avail NTIS HC \$9 25 CSCL 01C

The aerodynamic stability and control characteristics of a 0.087-scale model of an F-8 airplane fitted with an oblique wing was studied. The wing had an elliptical planform (axis ratio = 8:1) a maximum thickness of 12 percent and was tested at three sweep angles 0, 45 and 60 deg. Six-component force and moment data were measured at zero sideslip for angles of attack between -6 and +16 deg with the left and right ailerons deflected one at a time at angles between -14 deg and +14. Further tests were made with the horizontal tail deflected -5 and +2.5 deg. Test Mach numbers ranged from 0.6 to 1.4 at a Reynolds number of 20 million/m. Author

N76-22188* Technion - Israel Inst of Tech Haifa Dept of Aeronautical Engineering

AUTOMATED WING STRUCTURAL DESIGN Final Technical Report

Raphael T Haftka Nov 1975 12 p refs

(Grant NGR-52-012-008)

(NASA-CR-147142) Avail NTIS HC \$3 50 CSCL 01A

Research on the optimization of wing structures under multiple constraint such as strength displacement buckling flutter and divergence limits is reported. Advances were made in improving mathematical programming techniques as well as in improving the efficiency of constraint calculation. The WIDOWAC (Wing Design Optimization With Aeroelastic Constraints) computer program served as the main vehicle for this research. The methods developed were implemented in a general user oriented finite element program. Author

N76-22189* Transemanics Inc Washington D C

MECHANICAL FLAPS Progress Report

P Perrier and M Lavenant Washington NASA Feb 1976

38 p refs Transl into ENGLISH from AGARD Report AGARD-AP-133 Oct 1974

(Contract NASw-2792)

(NASA-TT-F-16875 AGARD-AP-133) Avail NTIS HC \$4 00 CSCL 01C

A wing with powerful mechanical high lift devices was designed with a combined use of theoretical aerodynamic methods and practical experience gained in the development of advanced mechanical systems. Wind tunnel tests on a complete model confirmed that this type of high lift scheme is a serious candidate for R/STOL aircraft applications. Author

N76-22190* Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany) Zentralabteilung Luftfahrttechnik

TYPICAL FLIGHT TESTS TO ESTABLISH THE PERFORMANCE OF THE LOCKHEED T 33 A AIRCRAFT [TYPISCHE FLUGVERSUCHE ZUR LEISTUNGSERMITTLUNG MIT DEM FLUGZEUG LOCKHEED T 33 A]

H Galleithner Dec 1974 87 p refs In GERMAN

(DLR-IB-555-74/12) Avail NTIS HC \$5 00

Performance was determined from five typical flight tests. The theoretical background, experimental procedure, evaluation and results of the flight tests are presented. Static pressure calibration from flights past a tower, required thrust, flow breaking, climbing flight law and turning flight performance in horizontal flights. ESA

N76-22191* European Space Agency Paris (France)

YAK 40 COCKPIT SYSTEM STUDY A PILOT OPINION SURVEY OF THE AIRCRAFT HANDLING AND SYSTEM QUALITIES

Konrad Steininger Guenter Neumann et al Feb 1976 56 p refs Transl into ENGLISH of Cockpit-Systemstudie YAK 40 Beurteilung der Cockpit-Einrichtungen Flug- u. Systemeigenschaften des Flugzeugmusters durch Piloten DFVLR Bonn Report DLR-FB-75-15 2 Jan 1975 Original German report available

from DFVLR Porz West Ger DM 24 90

(ESA-TT-259 DLR-FB-75-15) Avail NTIS \$4 50

A representative sample of pilots employed with an airline operating the Russian short haul jet transport aircraft YAK 40 assessed the acceptability of the cockpit layout and instrumentation, the handling quality and the feasibility of the systems with regard to the pilot's workload. The assessment of the concerned qualities was quantitatively conducted by using a 7-scale rating of 82 items of a questionnaire and qualitatively by tape-recorded descriptions of critical experiences with the aircraft. This method of subjective assessment, rating and description of a system has some justification in finding out both the critical weakness and the favorable points of an aircraft operation. It is a heuristic approach toward a direct recognition of the particular kind of strain involved and attention needed to cope with that aircraft operation. Author (ESA)

N76-22192* Technology Inc Dayton Ohio Instruments and Controls Div

DEVELOPMENT OF RMS COST MODEL AND DEMONSTRATION OF ALTERNATIVE OH-58 MAINTENANCE SCENARIOS Final Report, Jun 1974 - Nov 1975

Larry E Clay and James E Kirchmer Jul 1975 77 p refs (Contract DAAJ01-74-C-0839)

(AD-A017760 TI-069220-75-06 USAAVSCOM-TR-75-27) Avail NTIS CSCL 01/3

For several years the Army has employed the Reliability and Maintainability Simulator (RMS) computer program to simulate the operation and maintenance of helicopter fleets of up to 24 aircraft. However, since the basic RMS model did not include cost information, the economic consequences of changes in the maintenance procedures could not be projected, and the cost effectiveness of contemplated reliability improvements could not be evaluated. Consequently, to remedy these deficiencies, the RMS model was revised and expanded to an RMS COST model by adding a cost computation to determine all operating and maintenance costs during the simulation period. The resultant RMS COST model was demonstrated by executing a simulation of an OH-58 helicopter company with a baseline mission and maintenance system scenario and then with six alternative scenarios. GRA

N76-22194* Messerschmitt-Boelkow-Blohm G m b H Otto-brunn (West Germany) Unternehmensbereich Flugzeuge

COMPARATIVE STUDY OF MULTIPLEX SIGNAL TRANSMISSION ONBOARD AIRCRAFT USING CABLES OR FIBER OPTICS M S Thesis - Tech Univ Munich

Karl-Friedrich Finke 22 May 1974 101 p refs In GERMAN ENGLISH summary

(MBB-UFE-1098-O) Avail NTIS HC \$5 50

Principles and problems of data transfer via electric cables including trunk groups as well as via optical fibers, are investigated. The principal layout of data buses, both via cable and optical fiber as a transmission medium, is described and disadvantages of present data buses for aircraft are pointed out. A plan is developed for an onboard data bus-system. The potential realizations of such a system applying cable and optical fiber technology are discussed and compared with each other. As a result of these considerations, a proposal is presented for such a system using fiber optics technology. Author (ESA)

N76-22195* National Aerospace Lab, Amsterdam (Netherlands) Flight Div

A SIMULATOR EXPERIMENT TO INVESTIGATE A LATERAL RATE FIELD DISPLAY

P H Wewerinke 14 Jun 1974 48 p refs

(NLR-TR-74093-U) Avail NTIS HC \$4 00

To assess the use of linear rate field displays with respect to their alerting, directing and tracking functions, the results of an experimental program in a realistic task situation, namely a lateral position control task in the presence of lateral gust disturbances for a fighter aircraft, are presented. Two displays are included in the experimental setup: a three-axis attitude direction indicator and a cross track rate display. Various formats

were investigated. The status display configurations are compared with a flight director configuration whose design is briefly described and based on modern manual control theory. Experimental results reveal that the flight director configuration is superior to the status display configuration both in terms of system performance and pilot workload. Furthermore, it is apparent from the results that rate information is useful for the task considered. When provided by means of a moiré pattern, this information can be derived peripherally, which is important for high visual input load situations. The use of a secondary workload task is demonstrated and modifications are suggested. Author (ESA)

N76-22197*# Pratt and Whitney Aircraft East Hartford Conn
STUDY OF TURBOFAN ENGINES DESIGNED FOR LOW-ENERGY CONSUMPTION Final Report
D E Gray Apr 1976 119 p refs
(Contract NAS3-19132)
(NASA-CR-135002 PWA-5318) Avail NTIS HC \$5.50 CSCL 21E

The near-term technology improvements which can reduce the fuel consumed in the JT9D, JT8D, and JT3D turbofans in commercial fleet operation through the 1980s are identified. Projected technology advances are identified and evaluated for new turbofans to be developed after 1985. Programs are recommended for developing the necessary technology. Author

N76-22199*# Purdue Univ., Lafayette, Ind Thermal Sciences and Propulsion Center
TURBINE VANE GAS FILM COOLING WITH INJECTION IN THE LEADING EDGE REGION FROM A SINGLE ROW OF SPANWISE ANGLED HOLES Final Report, Feb 1972 - Jul 1975
Mel R Lecuyer and Gary J Hanus Apr 1976 337 p refs
Submitted for publication
(Grant NGR-15-005-147)
(NASA-CR-147160 TSPC-TR-76-1) Avail NTIS HC \$10.00 CSCL 21E

An experimental study of gas film cooling was conducted on a 3X size model turbine vane. Injection in the leading edge region was from a single row of holes angled in a spanwise direction. Measurements of the local heat flux downstream from the row of coolant holes, both with and without film coolant flow, were used to determine the film cooling performance presented in terms of the Stanton number ratio. Results for a range of coolant blowing ratio $M = 0$ to 2.0 indicate a reduction in heat flux of up to 15 to 30 percent at a point 10 to 11 hole diameters downstream from injection. An optimum coolant blowing ratio corresponds to a coolant-to-freestream velocity ratio in the range of 0.5. The shallow injection angle resulted in superior cooling performance for injection closest to stagnation, while the effect of injection angle was insignificant for injection further from stagnation. Author

N76-22200*# General Electric Co Cincinnati Ohio Aircraft Engine Group
BLADE ROW DYNAMIC DIGITAL COMPRESSOR PROGRAM VOLUME 1 J85 CLEAN INLET FLOW AND PARALLEL COMPRESSOR MODELS
W A Tesch and W G Steenken Mar 1976 218 p refs
(Contract NAS3-18526)
(NASA-CR-134978 R75AEG406) Avail NTIS HC \$7.75 CSCL 21E

The results are presented of a one-dimensional dynamic digital blade row compressor model study of a J85-13 engine operating with uniform and with circumferentially distorted inlet flow. Details of the geometry and the derived blade row characteristics used to simulate the clean inlet performance are given. A stability criterion based upon the self-developing unsteady internal flows near surge provided an accurate determination of the clean inlet surge line. The basic model was modified to include an arbitrary extent multi-sector parallel compressor configuration for investigating 180 deg 1/rev total pressure, total temperature, and combined total pressure and total temperature distortions. The combined distortions included opposed, coincident, and 90 deg overlapped patterns. The predicted losses in surge pressure ratio matched

the measured data trends at all speeds and gave accurate predictions at high corrected speeds where the slope of the speed lines approached the vertical. Author

N76-22202* National Aeronautics and Space Administration Langley Research Center, Langley Station Va
TWO DIMENSIONAL WEDGE/TRANSLATING SHROUD NOZZLE Patent Application
Donald L Maiden inventor (to NASA) Filed 31 Mar 1976 18 p
(NASA-Case-LAR-11919-1 US-Patent-Appl-SN-672221) Avail NTIS HC \$3.50 CSCL 21E

A jet propulsion exhaust nozzle particularly useful in multi-engine installations is described. The exhaust nozzle provides high internal/external thrust-minus-drag performance for transonic cruise or transonic acceleration as well as improved performance at subsonic and supersonic speeds. A two dimensional wedge/translating shroud at the nozzle exit gives the variable nozzle exit geometry needed to achieve high engine performance over a wide range of throttle power settings. NASA

N76-22203# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany) Zentralabteilung Luftfahrttechnik
SOUND ATTENUATOR FOR DO 27 [SCHALLDAEMPFER FUER DO 27]
K Seifert Jul 1974 21 p In GERMAN
(DLR-IB-555-74/4) Avail NTIS HC \$3.50

Two sound attenuators for the engine of the relatively noisy DO 27 H and DO 27 A aircraft were constructed and tested in an anechoic chamber. The choice of a combined attenuator consisting of a resonator and absorption part containing a pipe lining and a muffler is discussed. The flight noise of the DO 27 H is dealt with and the dimensions of the sound attenuator are detailed. Measuring equipment and measuring results are discussed. It is concluded that the level of attenuation reached will probably be sufficient. ESA

N76-22204# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Oberpfaffenhofen (West Germany) Zentralabteilung Luftfahrttechnik
NOISE LEVEL MEASUREMENTS IN COCKPITS AND CABINS OF DFVLR OBERPFAFFENHOFEN FLIGHT UNIT AIRCRAFT (RESULTS OF A FIRST SERIES OF MEASUREMENTS) [SCHALLPEGELMESSUNGEN IN COCKPIT UND KABINE VON FLUGZEUGEN DER DFVLR-FLUGBEREITSCHAFT OBERPFAFFENHOFEN (ERGEBNISSE EINER ERSTEN MESSREIHE)]
H Galleithner Dec 1974 20 p In GERMAN
(DLR-IB-555-74/11) Avail NTIS HC \$3.50

The noise at ear level of Dornier DO 27 and 28, Beech 65, Piaggio P149 D, and Cessna 207 aircraft was measured during typical flight phases on the runway during takeoff and during cruising. Results were tabulated. It is shown that the noise level of the different aircrafts can be classified, transforming the dB (A)-level into a dimensionless characteristic performance number which is a measure for the effective engine performance as a percentage of the continuous performance. ESA

N76-22212# Bristol Univ (England) Dept of Aeronautical Engineering
SOME EXPLORATORY STUDIES ON A PILOT'S AGGRAVATION OF AIRCRAFT RESPONSE TO ATMOSPHERIC TURBULENCE
M G Anthony, D L Birdsall, and R Stirling Apr 1974 30 p refs
(Grant SRC-B/SR/8168 6)
Avail NTIS HC \$4.00

The pilot's contribution to maintenance of control or to recovery when control has been lost during atmospheric turbulence flight of a jet transport was assessed. A transient record of atmospheric turbulence excites a longitudinal simulation of a large (rigid) jet transport while several dynamic parameters are recorded. A linear pilot model is allowed to respond to the

pitch rate and load factor at the cockpit, producing a column deflection for a range of pilot sensitivities and his delay. Two mechanisms for control are connected to the column, namely the conventional elevator and a trailing-edge high-speed flap subject to washout. It is shown that, subject to a number of simplifying assumptions, a very limited range of the sensitivities and delay will lead to an improvement in the pilot's ride. The safety of passengers elsewhere is to be questioned as the ride quality at aft stations can be seriously degraded by pilot action. Author (ESA)

N76-22213# European Space Agency Paris (France)
METHODS FOR PARAMETER INSENSITIVE CONTROL SYSTEM DESIGN WITH APPLICATION TO A CONTROL CONFIGURED VEHICLE (CCV)

Gerd Hirzinger and Gerhard Kreisselmeier Dec 1975 182 p refs. Transl into ENGLISH of Methoden zur Auslegung eines parameterunempfindlichen Regelungssystems u ihre Anwend fuer ein aerodynamisch instabiles Flugzeug (CCV) DFVLR Oberpfaffenhofen West Ger Report DLR-FB-75-40, 21 May 1975 Original German report available from DFVLR Cologne DM 56 80 (ESA-TT-225, DLR-FB-75-40) Avail NTIS HC \$7 50

Methods for the design of the systems are applied to control longitudinal motion (flight path control). For nominal flight conditions the controller design is simplified by introducing reference trajectories and optimizing over the controller coefficients. While nominal control system properties are maintained, its sensitivity with respect to plant parameter variations is reduced in a direct way by suitable readjustment of the controller structure and/or controller coefficients. Detailed simulation results illustrate the properties of the different control system designs. Author (ESA)

N76-22260*# Delco Electronics Santa Barbara Calif
ELECTROMECHANICAL FLIGHT CONTROL ACTUATOR

Feb 1976 68 p
 (Contract NAS9-14331)
 (NASA-CR-147557 R76-29) Avail NTIS HC \$4 50 CSCL 22B

An electromechanical actuator that will follow a proportional control command with minimum wasted energy is developed. The feasibility of meeting space vehicle actuator requirements using advanced electromechanical concepts is demonstrated. Recommendations for further development are given. Author

N76-22330*# Boeing Commercial Airplane Co Seattle, Wash
EVALUATION OF MATERIALS AND CONCEPTS FOR AIRCRAFT FIRE PROTECTION Final Report

Roy A Anderson James O Price, Allan H McClure and Everett A Tustin Apr 1976 38 p refs
 (Contract NAS2-7978)
 (NASA-CR-137838 D6-42614) Avail NTIS HC \$4 00 CSCL 21B

Woven fiberglass fluted-core simulated aircraft interior panels were flame tested and structurally evaluated against the Boeing 747 present baseline interior panels. The NASA-defined panels though inferior on a strength-to-weight basis showed better structural integrity after flame testing due to the woven fiberglass structure. Author

N76-22360# National Aerospace Lab Amsterdam (Netherlands)
Structures and Materials Div

HEAT TREATMENT STUDIES OF ALUMINIUM ALLOY FORGINGS OF THE AZ 74 61 TYPE THE EFFECT OF HEAT TREATMENT ON A VARIETY OF ENGINEERING PROPERTIES Interim Report

L Schra and H P vanLeeuwen Oct 1974 106 p refs Sponsored by the Directorate of Mater Air RNLAf
 (NLR-TR-74151-U IR-2) Avail NTIS HC \$5 50

The effect of a variety of heat treatments on engineering properties such as Vickers hardness short time tensile strength fatigue crack propagation resistance fracture toughness and stress corrosion resistance of AZ 74 61 type aluminum alloy forgings

was studied. It was found that at comparable strength crack tolerance properties were superior to those of the older aluminum forging alloys 7079 and DTD 5024. In particular, a better resistance to stress corrosion can be obtained with the present alloy. A further improvement in crack tolerance at the cost of only a slight loss in strength can be achieved if a secondary aging temperature of 180 deg is used instead of the 170 deg applied by Fuchs. Author (ESA)

N76-22367# Battelle Columbus Labs Ohio
ENGINEERING DATA ON NEW AEROSPACE STRUCTURAL MATERIALS Final Summary Report, Apr 1973 - Apr 1975

Omar L Deel, Paul E Ruff and H Mindlin Jun 1975 287 p (Contract F33615-73-C-5073 AF Proj 7381)
 (AD-A017848 AFML-TR-75-97) Avail NTIS CSCL 11/6

The major objectives of this research program were to evaluate newly developed materials of interest to the Air Force for potential structural airframe usage, and to provide 'data sheet type' presentations of engineering data for these materials. The effort covered in this report has concentrated on 7049-T7351 plate, Inconel 617 annealed sheet, 7475-T7351 plate, 2419-T851 plate, Ti-6Al-2Zr-2Sn-2Mo-2Cr duplex-annealed forging, Ti-6Al-2Cu-1Ta-1Mo annealed plate, Ti-6Al-4V beta-annealed plate, Ti-6Al-4V annealed castings, Ti-6Al-4V isothermal forgings, Incoloy 903 heat-treated sheet, and 2010 T7 castings. The properties investigated include tension, compression, shear, bend, impact, fracture toughness, fatigue, creep, and stress-rupture, and stress corrosion at selected temperatures. GRA

N76-22389# Air Force Systems Command, Wright-Patterson AFB Ohio Foreign Technology Div
CERMET FRICTION MATERIAL

B G Arabei, I I Zverev, M S Zukher, S S Kokenin and Yu M Markov 13 Nov 1975 10 p Transl into ENGLISH from a Russian Patent no 393344 10 Aug 1975 p 1-2
 (AD-A018168, FTD-ID(RS)-2316-75) Avail NTIS CSCL 11/7

The invention is related to the field of cermet friction materials which are used for braking gear for example aircraft brakes. The purpose of the invention is to raise the thermal, tensile and flexural strength. This is achieved by introducing graphite fiber into the proposed cermet friction material containing boron carbide, boron nitride, iron group metals and zirconium carbide. GRA

N76-22404# Air Force Aero Propulsion Lab, Wright-Patterson AFB Ohio

AVIATION TURBINE FUEL LUBRICITY EVALUATION OF CORROSION INHIBITORS Final Report, Jun 1973 - Mar 1974

Joseph Petrarca, Jr Sep 1975 53 p refs
 (AF Proj 3048)

(AD-A017376 AFAPL-TR-75-47) Avail NTIS CSCL 21/4

This report describes the evaluation of the effectiveness of corrosion inhibitors as fuel lubricity agents. The study was conducted with the Furey Ball-on-Cylinder. In the study, the eleven corrosion inhibitors from QPL-25017-9 were evaluated as lubricity agents in three base fluids at various concentrations and at the two base fluid temperatures of 75F and 150F. The rank effectiveness of the inhibitors correlated for the following two cases: (1) The inhibitors at their maximum allowable concentration in the three base fluids at 75F. (2) The inhibitors at three concentrations in the same base fluid at 75F. The rank effectiveness of the inhibitors did not correlate for the case where the corrosion inhibitors were at their maximum allowable concentrations in the same base fluid but at the two different temperatures of 75F and 150F. GRA

N76-22407# Air Force Systems Command Wright-Patterson AFB Ohio Foreign Technology Div
FUELS AND LUBRICANTS FOR AIRCRAFT

M E Reznikov 27 Feb 1975 342 p refs Transl into ENGLISH from the book *Topliva i Smazochnyye Materialy Dlya Letatelnykh Apparatov* Moscow 1973 p 1-231

(AD-A018261 FTD-HC-23-2134-74) Avail NTIS CSCL 21/4

Contents General characteristics of aircraft fuels Brief data on the production of fuels--Petroleum the basic raw material in fuel production Fuels for air breathing jet engines Aviation gasoline--Piston engines and fuel requirements Rocket propellants, Lubricants and technical fluids Production of synthetic oils and liquids Oils for aircraft engines Transmission oils Greases GRA

N76-22419*# Ohio State Univ Columbus ElectroScience Lab

VOLUMETRIC PATTERN ANALYSIS OF FUSELAGE-MOUNTED AIRBORNE ANTENNAS Ph D Thesis

Chong L Yu Apr 1976 200 p refs

(Grant NGL-36-008-138)

(NASA-CR-147099 TR-2902-24) Avail NTIS HC \$7 50 CSCL 17B

A volumetric pattern analysis of fuselage-mounted airborne antennas at high frequencies was investigated. The primary goal of the investigation was to develop a numerical solution for predicting radiation patterns of airborne antennas in an accurate and efficient manner. An analytical study of airborne antenna pattern problems is presented in which the antenna is mounted on the fuselage near the top or bottom. Since this is a study of general-type commercial aircraft the aircraft was modeled in its most basic form. The fuselage was assumed to be an infinitely long perfectly conducting elliptic cylinder in its cross-section and a composite elliptic cylinder in its elevation profile. The wing cockpit stabilizers (horizontal and vertical) and landing gear are modeled by N sided bent or flat plates which can be arbitrarily attached to the fuselage. The volumetric solution developed utilizes two elliptic cylinders namely the roll plane and elevation plane models to approximate the principal surface profile (longitudinal and transverse) at the antenna location. With the belt concept and the aid of appropriate coordinate system transformations the solution can be used to predict the volumetric patterns of airborne antennas in an accurate and efficient manner. Applications of this solution to various airborne antenna problems show good agreement with scale model measurements. Extensive data are presented for a microwave landing antenna system. Author

N76-22544*# Rensselaer Polytechnic Inst, Troy NY Tribology Lab

THE DESIGN OF AIRCRAFT BRAKE SYSTEMS, EMPLOYING COOLING TO INCREASE BRAKE LIFE

R P Scaringe Ting-Long Ho and Marshall B Peterson Oct 1975 52 p refs

(Grant NGR-33-018-152)

(NASA-CR-134980) Avail NTIS HC \$4 50 CSCL 13L

A research program was initiated to determine the feasibility of using cooling to increase brake life. An air cooling scheme was proposed constructed and tested with various designs. Straight and curved slotting of the friction material was tested. A water cooling technique similar to the air cooling procedure was evaluated on a curved slotted rotor. Also investigated was the possibility of using a phase-change material within the rotor to absorb heat during braking. Various phase-changing materials were tabulated and a 50% (by weight) LiF - BeF₂ mixing was chosen. It was shown that corrosion was not a problem with this mixture. A preliminary design was evaluated on an actual brake. Results showed that significant improvements in lowering the surface temperature of the brake occurred when air or water cooling was used in conjunction with curved slotted rotors.

Author

N76-22567 Indian Inst of Tech Kanpur Dept of Aeronautical Engineering

SOME RECENT TRENDS IN AIRCRAFT FLUTTER RESEARCH

P N Murthy In NRL The Shock and Vibration Bull, Vol 7

No 12 Dec 1975 Dec 1975 p 71-76 refs

CSCL 13/13

Research and development work completed during the last 3 to 5 years in the area of aircraft flutter (excluding however the subject of panel flutter) was reviewed. The following areas were discussed: (1) modelling of the aircraft (2) critical modes for flutter (3) effect of additional masses (4) solution of flutter determinant (5) system identification and (6) flutter control and prevention. The most important of the technological innovations in the area of flutter control and prevention is the feedback control loop leading to the now well-known control configured vehicles. Author

N76-22584*# Lockheed Electronics Co Houston Tex Aerospace Systems Div

DETAILED REQUIREMENTS DOCUMENT FOR THE INTEGRATED STRUCTURAL ANALYSIS SYSTEM, PHASE B

John A Rainey Jan 1976 632 p refs

(Contract NAS9-12200)

(NASA-CR-147550 LEC-5809 JSC-09811) Avail NTIS HC \$16 25 CSCL 13M

The requirements are defined for a software system entitled integrated Structural Analysis System (ISAS) Phase B which is being developed to provide the user with a tool by which a complete and detailed analysis of a complex structural system can be performed. This software system will allow for automated interface with numerous structural analysis batch programs and for user interaction in the creation, selection, and validation of data. This system will include modifications to the 4 functions developed for ISAS and the development of 25 new functions. The new functions are described. Author

N76-22598# National Aerospace Lab, Amsterdam (Netherlands) Structures and Materials Div

INTRODUCTION TO A FIGHTER AIRCRAFT LOADING STANDARD FOR FATIGUE EVALUATION (FALSTAFF)

G M VanDijk and J B DeJonge 20 May 1975 40 p refs

Presented at the 8th Intern Comm on Aeron Fatigue Symp Lausanne Switz 2-5 Jun 1975

(Contract RNLA-FB-KLU-P 32)

(NLR-MP-75017-U) Avail NTIS HC \$4 00

Falstaff (Fighter Aircraft Loading Standard for Fatigue Evaluation) a loading history standard pertaining to fighter aircraft wing bending primarily governed by maneuver loadings is derived in order to evaluate the fatigue performance of structural materials and components and to establish fatigue design charts. The present report concerns a joint international development effort involving Dutch, German, and Swiss institutes. Details are presented with regard to the general development philosophy and data sources considered. The development procedures followed are summarized. The results of some preliminary validation tests are reported.

Author (ESA)

N76-22610# Syracuse Univ NY Dept of Mechanical and Aerospace Engineering

STIFFNESS AND STRESS ANALYSIS OF DISCRETELY ATTACHED CORRUGATED SHEAR WEBS WITH QUASI-SINUSOIDAL CORRUGATIONS

Lung-Hsiang Wu and Charles Libove Jul 1975 98 p refs

(Grant NSF ENG-72-04101-A02)

(PB-248728/8 MAE-5170-T5) Avail NTIS HC \$5 00 CSCL 13M

A theoretical analysis and numerical data are presented for the shear stiffness of curvilinearly corrugated shear webs with discrete attachments to framing members at the ends of the corrugations and for the maximum transverse extreme-fiber flexural stresses and strains due to the cross-sectional deformations which arise during the shearing of such webs. The particular type of curvilinear cross-section assumed here is one in which the curvature varies sinusoidally from crest to trough. It was found that with discrete attachments these two types of curvilinear

corrugations could differ significantly in their shear stiffness and in their transverse flexural stresses and strains GRA

N76-22977*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

NOISE REDUCTION TESTS OF LARGE-SCALE-MODEL EXTERNALLY BLOWN FLAP USING TRAILING-EDGE BLOWING AND PARTIAL FLAP SLOT COVERING

Daniel J McKinzie, Jr., Robert J Burns and Jack M Wagner Washington Apr 1976 65 p refs (NASA-TM-X-3379 E-8598) Avail NTIS HC \$4 50 CSCL 20A

Noise data were obtained with a large-scale cold-flow model of a two-flap under-the-wing, externally blown flap proposed for use on future STOL aircraft. The noise suppression effectiveness of locating a slot conical nozzle at the trailing edge of the second flap and of applying partial covers to the slots between the wing and flaps was evaluated. Overall sound-pressure-level reductions of 5 db occurred below the wing in the flyover plane. Existing models of several noise sources were applied to the test results. The resulting analytical relation compares favorably with the test data. The noise source mechanisms were analyzed and are discussed. Author

N76-23153*# Air Force Systems Command Wright-Patterson AFB Ohio

THOUGHTS ON THE FUTURE TASKS OF THE EUROPEAN AVIATION INDUSTRY IN THE REALM OF CIVIL AVIATION

Claudius Dornier Jr. 21 Nov 1975 22 p Transl into ENGLISH from Der Flieger (West Germany), v 55, no 6, Jun 1975 p 221-226 (AD-A018470 FTD-ID(RS)-2214-75) Avail NTIS CSCL 01/2

A report is made on the past deficiencies in the European air transportation industry, and on some possibilities for future developments. GRA

N76-23154 Virginia Polytechnic Inst and State Univ Blacksburg **FLUTTER OF LAMINATED PLATES IN SUPERSONIC FLOW Ph D Thesis**

James Wayne Sawyer 1975 132 p Avail Univ Microfilms Order No 76-11272

A procedure was developed for solving flutter problems of simply supported laminated plates using linear small deflection theory. The plate construction may be arbitrary as long as it satisfies the assumptions of linear small deflection theory. For such plates the bending and extensional governing equations are coupled and have cross-stiffness terms which do not appear in classical plate theory. The coupling and cross-stiffness terms occur as a result of the lamina principal directions (fibers) not coinciding with the neutral surface of the plate. The extended Galerkin method is used to obtain approximate solutions to the governing equations where the aerodynamic pressure loading used in the analysis is that given by linear piston theory with flow at arbitrary cross-flow angles. Dissert Abstr

N76-23155 Texas Univ, Arlington **WING LOADING THEORY SATISFYING ALL BOUNDARY POINTS Ph D Thesis**

John DeYoung 1975 180 p Avail Univ Microfilms Order No 76-11674

Subsonic wing loading theories are developed to satisfy boundary conditions of the wing analytically at all points. This approach is applied to lifting line theory and to lattice vortex theory. A load line theory is developed for which boundary conditions are satisfied at all points spanwise along the load line. With the introduction of an induced angle parameter, this load line theory has the accuracy of lifting surface theory but the analytical simplicity of lifting line theory. The load line theory provides a means for the analytical determination of ideal tapered

wings. Swept wing parameters are developed which make load line theory applicable to arbitrary planform. Because load line theory is quasi two-dimensional it is ideally suited for the more complex type of loading solutions such as taking into account interference effects of fuselage jets, multiplanes. Dissert Abstr

N76-23159*# McDonnell-Douglas Corp Long Beach, Calif **CORRECTION FACTORY TECHNIQUES FOR IMPROVING AERODYNAMIC PREDICTION METHODS Final Report**

Joseph P Giesing, Terez P Kalman, and William P Rodden May 1976 288 p refs (Contract NAS1-13835) (NASA-CR-144967) Avail NTIS HC \$9 25 CSCL 01A

A method for correcting discrete element lifting surface theory to reflect given experimental data is presented. Theoretical pressures are modified such that imposed constraints are satisfied while minimizing the changes to the pressures. Several types of correction procedures are presented and correlated, (1) scaling of pressures, (2) scaling of downwash values, and (3) addition of an increment to the downwash that is proportioned to pressure. Some special features are included in these methods and they include (1) consideration of experimental data from multiple deflection modes, (2) limitation of the amplitudes of the correction factors, and (3) the use of correction factor mode shapes. These methods are correlated for cases involving all three Mach Number ranges using a FORTRAN IV computer program. Subsonically, a wing with an oscillating partial span control surface and a wing with a leading edge droop are presented. Transonically a two-dimensional airfoil with an oscillating flap is considered. Supersonically an arrow wing with and without camber is analyzed. In addition to correction factor methods an investigation is presented dealing with a new simplified transonic modification of the two-dimensional subsonic lifting surface theory. Correlations are presented for an airfoil with an oscillating flap. Author

N76-23160*# Polytechnic Inst of New York Aerodynamics Labs

CALCULATION OF THE THREE-DIMENSIONAL, SUPERSONIC, INVISCID, STEADY FLOW PAST AN ARROW-WINGED AIRFRAME, PART 1 Interim Report

Gino Moretti May 1976 38 p refs (Grant NsG-1248) (NASA-CR-147230 POLY-AE/AM-76-8-Pt-1) Avail NTIS HC \$4 00 CSCL 01A

A detailed description of the procedure used to compute three dimensional, supersonic, inviscid steady flows past airframes is given. No limitations are imposed on the geometry of the airplane. Suitable computational grids are generated by automatic conformal mappings. The equations of motion, with pressure, entropy, and velocity direction as basic unknowns, are written and discretized in the computational space. Special rules to approximate derivatives are given. Boundary points are treated by a modified method of characteristics. Author

N76-23162*# National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif

A SUBMERGED SINGULARITY METHOD FOR CALCULATING POTENTIAL FLOW VELOCITIES AT ARBITRARY NEAR-FIELD POINTS

Brian Maskew Mar 1976 45 p refs (NASA-TM-X-73115, A-6498) Avail NTIS HC \$4 00 CSCL 01A

A discrete singularity method has been developed for calculating the potential flow around two-dimensional airfoils. The objective was to calculate velocities at any arbitrary point in the flow field, including points that approach the airfoil surface. That objective was achieved and is demonstrated here on a Joukowski airfoil. The method used combined vortices and sources "submerged" a small distance below the airfoil surface and incorporated a near-field subvortex technique developed earlier. When a velocity calculation point approached the airfoil surface, the number of discrete singularities effectively increased (but

only locally) to keep the point just outside the error region of the submerged singularity discretization. The method could be extended to three dimensions, and should improve nonlinear methods which calculate interference effects between multiple wings, and which include the effects of force-free trailing vortex sheets. The capability demonstrated here would extend the scope of such calculations to allow the close approach of wings and vortex sheets (or vortices) Author

N76-23163# Advisory Group for Aerospace Research and Development Paris (France)

A COMPARISON OF METHODS USED IN INTERFERING LIFTING SURFACE THEORY

W P Rodden Feb 1976 68 p refs
(AGARD-R-643-Suppl. ISBN-92-835-1210-3) Avail NTIS HC \$4 50

Flow field prediction methods for interfering lifting surfaces cover subsonic and supersonic aerodynamic loads

N76-23164 Advisory Group for Aerospace Research and Development, Paris (France)

INTERFERENCE AND NONPLANAR LIFTING SURFACE THEORIES

William P. Rodden (La Canada, Calif.) *In its* A Comparison of Methods Used in Interfering Lifting Surface Theory Feb 1976 p 2-5

The latest prediction methods for unsteady aerodynamic forces acting on interfering lift configurations are discussed. The collocation method and finite element analysis are applied to subsonic flows. Supersonic procedures include the box integration method, the box collocation method, and the collocation method G G

N76-23165 Advisory Group for Aerospace Research and Development Paris (France)

THE NONPLANAR KERNEL FUNCTIONS

William P. Rodden (La Canada, Calif.) *In its* A Comparison of Methods Used in Interfering Lifting Surface Theory Feb 1976 p 5-9

Nonplanar acceleration potential aspects for the kernels of the lifting surface integral equation are developed for the subsonic case. A velocity potential kernel is applied to supersonic flow analysis G G

N76-23166 Advisory Group for Aerospace Research and Development Paris (France)

SUBSONIC METHODS

William P. Rodden (La Canada, Calif.) *In its* A Comparison of Methods Used in Interfering Lifting Surface Theory Feb 1976 p 9-12

Kernel function and Doublet-Lattice Method (DLM) applications for solving subsonic lifting surface problems are outlined. The first method uses chordwise collocation points to evaluate downwash, and the second method applies finite element analysis to obtain downwash expressions G G

N76-23167 Advisory Group for Aerospace Research and Development Paris (France)

SUPERSONIC METHODS

William P. Rodden (La Canada, Calif.) *In its* A Comparison of Methods Used in Interfering Lifting Surface Theory Feb 1976 p 12-13

Refined Mach box integration procedures are reported for numerical analysis of supersonic lifting surface interference effects G G

N76-23168 Advisory Group for Aerospace Research and Development Paris (France)

PREFACE TO FIGURES AND TABLES

William P. Rodden (La Canada, Calif.) *In its* A Comparison of Methods Used in Interfering Lifting Surface Theory Feb 1976 p 13-25 refs

Data are compared from three different solutions of the lifting surface problem. The first task is the determination of the flow field, i.e., the velocity components in the field surrounding the oscillating wing. The second task is the calculation of the interference loading, i.e., lift and moment coefficients, on two surfaces induced by the motion of the forward surface. The third task is the calculation of the generalized forces resulting from the motions of the various components of an interfering wing-horizontal tail-fin configuration. The computation of each of these derived quantities from the solution of the basic lifting surface problem is indicated below Author

N76-23169*# George Washington Univ., Washington, D C
COMPUTATIONAL ASPECTS OF REAL-TIME SIMULATION OF ROTARY-WING AIRCRAFT M S Thesis

Jacob Albert Houck May 1976 125 p refs Sponsored by NASA
(NASA-CR-147932) Avail NTIS HC \$5 50 CSCL 01A

A study was conducted to determine the effects of degrading a rotating blade element rotor mathematical model suitable for real-time simulation of rotorcraft. Three methods of degradation were studied: reduction of number of blades, reduction of number of blade segments, and increasing the integration interval, which has the corresponding effect of increasing blade azimuthal advance angle. The three degradation methods were studied through static trim comparisons, total rotor force and moment comparisons, single blade force and moment comparisons over one complete revolution, and total vehicle dynamic response comparisons. Recommendations are made concerning model degradation which should serve as a guide for future users of this mathematical model, and in general, they are in order of minimum impact on model validity: (1) reduction of number of blade segments, (2) reduction of number of blades, and (3) increase of integration interval and azimuthal advance angle. Extreme limits are specified beyond which a different rotor mathematical model should be used Author

N76-23170*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
EFFECT OF REYNOLDS NUMBER ON THE AERODYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF A 55 DEG CLIPPED-DELTA-WING ORBITER CONFIGURATION AT SUPERSONIC MACH NUMBERS

A B Blair, Jr. Washington May 1976 97 p refs
(NASA-TM-X-3376 L-10752) Avail NTIS HC \$5 00 CSCL 01A

A wind-tunnel investigation has been conducted at Mach numbers from 1.60 to 4.63 for Reynolds numbers varying from approximately 0.8 million to 10.0 million (based on body length) to determine the Reynolds number effects on the static longitudinal and lateral aerodynamic stability and control characteristics of two scale models of the Grumman H-33 space shuttle orbiter. The results indicate that for the Reynolds number range investigated, there are no Reynolds number effects on the longitudinal or lateral aerodynamic characteristics of either model with zero control deflections and only negligible effects with control deflections. The roll control is constant for both models with the possible exception of a slight increase with increases in Reynolds number up to 2.0 million at the lower Mach numbers. This very small Reynolds number effect is much more apparent for the smaller model and disappears with increasing Mach and Reynolds numbers Author

N76-23172# National Aviation Facilities Experimental Center, Atlantic City NJ

MEASUREMENT OF THE TRAILING VORTEX SYSTEMS OF LARGE TRANSPORT AIRCRAFT, USING TOWER FLY-BY AND FLOW VISUALIZATION (SUMMARY, COMPARISON AND APPLICATION) Final Report, Apr 1971 - Nov 1973

Leo J. Garodz, David M. Lawrence, and Nelson J. Miller Jan 1976 271 p refs
(AD-A021305/8, FAA-NA-75-3, FAA-RD-75-127) Avail NTIS HC \$9 00 CSCL 20/4

Full-scale flight test investigations were made of the

characteristics, persistence and movement of the trailing vortices generated by propeller and jet transport aircraft using tower fly-by and vortex flow visualization. The results are summarized and comparisons made of the vortices of the Douglas DC10, DC9, and DC7 Boeing 747, 727, and 707, Lockheed C5A, C141 and L1011, and the Convair 880 aircraft. Vortex mathematical models and decay mechanisms are discussed. Their effects (upset potential) on encountering aircraft were investigated for possible air traffic control application. Author

**N76-23173*# Kanner (Leo) Associates, Redwood City, Calif
COMPARISON OF THEORETICAL AND EXPERIMENTAL
PROFILE DRAGS**

R Eppler Washington NASA Apr 1976 12 p refs Transl into ENGLISH from Schweizer Aero-Rev (Switzerland) v 38, no 10, Oct 1963 p 593-595
(Contract NASw-2790)
(NASA-TT-F-16981) Avail NTIS HC \$3 50 CSCL 01A

Experimental values of profile drags were compared with calculated values, the latter obtained from potential theory and boundary-layer theory. When there is no separation, agreement is good. The theory also predicts the point at which the separation level appears but not the drag from then on. Small separations are found to be more detrimental to lift than to drag. Author

**N76-23175# Air Force Flight Dynamics Lab, Wright-Patterson
AFB Ohio**

**PREDICTION OF THE PRESSURE OSCILLATIONS IN
CAVITIES EXPOSED TO AERODYNAMIC FLOW**

D L Smith and L L Shaw Oct 1975 92 p refs
(AF Proj 1471)

(AD-A018518 AFFDL-TR-75-34) Avail NTIS CSCL 20/4

Cavities or rectangular cutouts exposed to fluid flow can produce an intense aero-acoustic environment. Past experience has shown that severe fluctuating pressures exist in open aircraft weapon bays under certain flight conditions. The aircraft designer must be able to predict the fluctuating pressure environment of cavities in order to assess the effects on the internally carried stores or near-by structure. Prediction methods were formulated based primarily on data from flight tests on cavities with length-to-depth-ratios of 4, 5 and 7 over a Mach number range of 0.6 to 1.30. Available data in the literature were then used to extend the range of application of the prediction method to cavities with length to depth ratios from 2 to 7 and for Mach numbers from 0.5 to 3.0. GRA

**N76-23180 Pennsylvania State Univ University Park
SUPPLY FUNCTIONS FOR SHORT-HAUL AIR TRANSPORTATION Ph D Thesis**

Francis X McKelvey 1975 193 p
Avail Univ Microfilms Order No 76-10761

Supply functions are generated for the individual aircraft used in the short-haul air transportation context. They are used to identify optimal aircraft to be employed under a variety of objective functions for various planning contexts. A measure of the quality of service, the level of service index, for short-haul air transportation is formulated which incorporates both the performance characteristics of aircraft and the operating and routing constraints found in the short-haul industry. This measure is used to gain a descriptive understanding of the performance of short-haul air transportation with respect to the private automobile. Several applications of the supply function are demonstrated to show the variety of its uses. Sensitivity analyses are conducted on the variables in order to discover the effect of certain operating and routing conditions on the quality of service. Dissert Abstr

**N76-23181*# National Aeronautics and Space Administration
Lyndon B Johnson Space Center Houston Tex
FULL-SCALE AIRCRAFT CABIN FLAMMABILITY TESTS OF
IMPROVED FIRE-RESISTANT MATERIALS, TEST
SERIES 2**

Robert N Stuckey Richard W Bricker Jerome F Kuminecz and Daniel E Supkis Apr 1976 62 p refs

(NASA-TM-X-58172, JSC-10613) Avail NTIS HC \$4 50 CSCL 01C

Full-scale aircraft flammability tests in which the effectiveness of new fire-resistant materials was evaluated by comparing their burning characteristics with those of other fire-resistant aircraft materials were described. New-fire-resistant materials that are more economical and better suited for aircraft use than the previously tested fire-resistant materials were tested. The fuel ignition source for one test was JP-4, a smokeless fuel was used for the other test. Test objectives, methods, materials, and results are presented and discussed. The results indicate that similar to the fire-resistant materials tested previously, the new materials decompose rather than ignite and do not support fire propagation. Furthermore, the new materials did not produce a flash fire. Author

**N76-23182*# Massachusetts Inst of Tech, Cambridge
Aeroelastic and Structures Research Lab**

**USER'S GUIDE TO COMPUTER PROGRAM CIVM-JET 4B
TO CALCULATE THE TRANSIENT STRUCTURAL RE-
SPONSES OF PARTIAL AND/OR COMPLETE STRUCTURAL
RINGS TO ENGINE-ROTOR-FRAGMENT IMPACT**

Thomas R Stagliano Robert L Spilker and Emmett A Witmer Mar 1976 297 p refs

(Contract NGR-22-009-339)

(NASA-CR-134907, ASRL-TR-154-9) Avail NTIS HC \$9 25 CSCL 01C

A user-oriented computer program CIVM-JET 4B is described to predict the large-deflection elastic-plastic structural responses of fragment impacted single-layer (a) partial-ring fragment containment or deflector structure or (b) complete-ring fragment containment structure. These two types of structures may be either free or supported in various ways. Supports accommodated include (1) point supports such as pinned-fixed, ideally-clamped, or supported by a structural branch simulating mounting-bracket structure and (2) elastic foundation support distributed over selected regions of the structure. The initial geometry of each partial or complete ring may be circular or arbitrarily curved, uniform or variable thicknesses of the structure are accommodated. The structural material is assumed to be initially isotropic, strain hardening and strain rate effects are taken into account. Author

**N76-23249*# ECON Inc, Princeton NJ
AN ASSESSMENT OF THE BENEFITS OF THE USE OF
NASA DEVELOPED FUEL CONSERVATIVE TECHNOLOGY
IN THE US COMMERCIAL AIRCRAFT FLEET**

6 Oct 1975 84 p refs Revised

(Contract NASw-2781)

(NASA-CR-148148 Rept-75-163-1) Avail NTIS HC \$5 00 CSCL 01C

Cost and benefits of a fuel conservative aircraft technology program proposed by NASA are estimated. NASA defined six separate technology elements for the proposed program: (a) engine component improvement, (b) composite structures, (c) turboprops, (d) laminar flow control, (e) fuel conservative engine, and (f) fuel conservative transport. There were two levels postulated. The baseline program was estimated to cost \$490 million over 10 years with peak funding in 1980. The level two program was estimated to cost an additional \$180 million also over 10 years. Discussions with NASA and with representatives of the major commercial airframe manufacturers were held to estimate the combinations of the technology elements most likely to be implemented, the potential fuel savings from each combination, and reasonable dates for incorporation of these new aircraft into the fleet. Author

**N76-23250*# Boeing Vertol Co, Philadelphia, Pa
IDENTIFYING AND ANALYZING METHODS FOR REDUC-
ING THE ENERGY CONSUMPTION OF HELICOPTERS**

S J Davis and H J Rosenstein Nov 1975 267 p refs

(Contract NAS1-13624)

(NASA-CR-144953, D210-11007-1) Avail NTIS HC \$9 00 CSCL 01C

The results are presented of a study to identify those helicopter technology areas which would result in the largest energy (or fuel) savings when applied to large tandem (100 passenger) civil helicopters in the 1985 time frame. Baseline aircraft using 1975 technology in the areas of powerplant rotor efficiency, parasite drag and structure were sized to a very short haul mission of 100 NM and a short haul mission of 200 NM. A systematic parametric analysis was then conducted to assess the impact of technology improvements. Projections of the technology levels that could be obtained in the 1985 time frame were made and the resources estimated to achieve them. Based on these data, the highest payoff (lowest energy) helicopter technologies are identified. Author

N76-23252*# Lockheed-California Co Burbank
YF-12 LOCKALLOY VENTRAL FIN PROGRAM, VOLUME 1
Final Report

R J Duba, A C Haramis, R F Marks, L Payne, and R C Sessing 9 Jan 1976 453 p Sponsored by NASA and USAF 2 Vol

(NASA-CR-144971) Avail NTIS HC \$12 00 CSCL 01C

Results are presented of the YF-12 Lockalloy Ventral Fin Program which was carried out by Lockheed Aircraft Corporation - Advanced Development Projects for the joint NASA/USAF YF-12 Project. The primary purpose of the program was to redesign and fabricate the ventral fin of the YF-12 research airplane (to reduce flutter) using Lockalloy, and alloy of beryllium and aluminum as a major structural material. A secondary purpose was to make a material characterization study (thermodynamic properties, corrosion, fatigue tests, mechanical properties) of Lockalloy to validate the design of the ventral fin and expand the existing data base on this material. All significant information pertinent to the design and fabrication of the ventral fin is covered. Emphasis throughout is given to Lockalloy fabrication and machining techniques and attendant personnel safety precautions. Costs are also examined. Photographs of tested alloy specimens are shown along with the test equipment used. Author

N76-23253*# Lockheed-California Co; Burbank
YF-12 LOCKALLOY VENTRAL FIN PROGRAM, VOLUME 2
Final Report

R J Duba, A C Haramis, R F Marks, L Payne, and R C Sessing 9 Jan 1976 157 p refs 2 Vol

(NASA-CR-144972) Avail NTIS HC \$6 75 CSCL 01C
 For abstract, see N76-23252

N76-23254# Committee on Armed Services (U S Senate)
ENFORCER AIRCRAFT

Washington GPO 1975 151 p Hearing before Subcomm on R and D of Comm on Armed Services, 94th Congr, 1st Sess 29-30 Jul 1975
 (GPO-56-607) Avail Subcomm on R and D

The hearings concerning the capabilities of the Enforcer as a Close Air Support Aircraft are reported. F O S

N76-23255# Army Aviation Engineering Flight Activity, Edwards AFB Calif

ARMY PRELIMINARY EVALUATION YAH-1R IMPROVED COBRA AGILITY AND MANEUVERABILITY HELICOPTER
Final Report, 17 Feb - 7 Mar 1975

Robert L Stewart, Floyd L Dominick Jr., and Raymond B Smith May 1975 35 p refs
 (AD-A018420 USAAFEA-74-33) Avail NTIS CSCL 01/3

The United States Army Aviation Engineering Flight Activity conducted in 1975 on preliminary evaluation of the improved Cobra agility and maneuverability helicopter, designated the YAH-1R. During the test 17 flights were flown for a total of 200 flight hours 129 of which were productive. Testing was limited to an evaluation of aircraft handling qualities with emphasis on low-speed flight characteristics at gross weights of approximately 10 000 pounds. Numerous recommendations are made concerning improvement to the power management system of the YAH-1R helicopter. A total of 15 shortcomings were identified. GRA

N76-23256# Air Force Flight Dynamics Lab, Wright-Patterson AFB, Ohio

AIRCRAFT FLIGHT PERFORMANCE METHODS Final Report, Jun 1974 - Jul 1975

Linn Earl Miller and Phillip G Koch Jul 1975 284 p (AF Proj 1366)

(AD-A018547, AFFDL-TR-75-89) Avail NTIS CSCL 01/1

This report addresses the problems associated with the derivation of aircraft performance characteristics. The emphasis is on segments which are a part of a mission profile. In particular the following areas are studied: takeoff, climb, cruise, descent and glide, turning, and landing. The generalized approach to performance estimates is first presented. Next, appropriate solutions are derived. Last sensitivity relationships are developed. The relationships determine changes in the performance characteristics as a result of an aircraft configuration change. This permits rapid evaluation of the performance variations for any segment of a mission profile. Author (GRA)

N76-23264*# National Aeronautics and Space Administration
Langley Research Center, Langley Station Va

HYPERSONIC RESEARCH ENGINE/AEROTHERMODYNAMIC INTEGRATION MODEL, EXPERIMENTAL RESULTS VOLUME 1 MACH 6 COMPONENT INTEGRATION

Earl H Andrews, Jr and Ernest A Mackley Apr 1976 376 p refs Prepared in cooperation with AirResearch Mfg Co Los Angeles Calif

(Contract NAS1-6666)

(NASA-TM-X-72821) Avail NTIS HC \$10 75 CSCL 21E

The NASA Hypersonic Research Engine (HRE) Project was initiated for the purpose of advancing the technology of airbreathing propulsion for hypersonic flight. A large component (inlet combustor and nozzle) and structures development program was encompassed by the project. The tests of a full-scale (18 in diameter cowl and 87 in long) HRE concept designated the Aerothermodynamic Integration Model (AIM), at Mach numbers of 5, 6, and 7. Computer program results for Mach 6 component integration tests are presented. Author

N76-23265*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio

NOISE COMPARISONS OF SINGLE AND TWO STAGE DEMONSTRATOR FANS FOR ADVANCED TECHNOLOGY AIRCRAFT

Marcus F Heidmann 1976 18 p refs Proposed for Presentation at the Third Aeroacoustics Conf, Palo Alto Calif, 20-23 Jul 1976, sponsored by AIAA
 (NASA-TM-X-71899 E-8688) Avail NTIS HC \$3 50 CSCL 20A

A high-speed single-stage and a low-speed two-stage fan were designed, fabricated and tested to demonstrate their predicted low noise performance for an advanced 0.85-0.90 cruise Mach number aircraft requiring a 1.8-1.9 pressure ratio fan. Acoustic tests were made with both unsuppressed and suppressed configurations. The two-stage fan demonstrated that quiet fan technology developed for low-speed single-stage fan is applicable to two-stage designs. The unsuppressed high-speed single-stage fan demonstrated that significant reductions in inlet noise can be achieved from the sonic blockage caused by supersonic flow in the rotor blading. Both fans demonstrated suppressed inlet noise levels with treated sonic inlets that met advanced technology goals. Author

N76-23267*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio

RESULTS OF THE POLLUTION REDUCTION TECHNOLOGY PROGRAM FOR TURBOPROP ENGINES

Edward J Mularz 1976 13 p refs Proposed for Presentation at the Twelfth Propulsion Conf, Palo Alto, Calif, 26-29 Jul 1976 Cosponsored by AIAA and SAE
 (NASA-TM-X-71911 E-8713) Avail NTIS HC \$3 50 CSCL 21E

A program was performed to evolve and demonstrate advanced combustor technology aimed at achieving the 1979 EPA standards for turboprop engines (Class P2). The engine selected for this program was the 501-D22A turboprop. Three combustor concepts were designed and tested in a combustor rig at the exact combustor operating conditions of the 50-D22A engine over the EPA landing-takeoff cycle. Each combustor concept exhibited pollutant emissions well below the EPA standards, achieving substantial reductions in unburned hydrocarbons, carbon monoxide and smoke emissions compared with emissions from the production combustor of this engine. Oxides of nitrogen emissions remained well below the EPA standards also.

Author

N76-23268*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio

NOISE REDUCTION AS AFFECTED BY THE EXTENT AND DISTRIBUTION OF ACOUSTIC TREATMENT IN A TURBOFAN ENGINE INLET

Gene L. Minner and Len Homyak 1976 18 p refs Presented at 3d Aero-Acoustics Conf Palo Alto Calif 20-22 Jul 1976, sponsored by AIAA
(NASA-TM-X-71904, E-8693) Avail NTIS HC \$3 50 CSCL 20A

An inlet noise suppressor for a TF-34 engine designed to have three acoustically treated rings was tested with several different ring arrangements. The configurations included all three rings, two outer rings, single outer ring, single intermediate ring and finally no rings. It was expected that as rings were removed, the acoustic performance would be degraded considerably. While a degradation occurred it was not as large as predictions indicated. The prediction showed good agreement with the data only for the full-ring inlet configuration. The underpredictions which occurred with ring removal were believed a result of ignoring the presence of spinning modes which are known to damp more rapidly in cylindrical ducts than would be predicted by least attenuated mode or plane wave analysis.

Author

N76-23272*# National Aeronautics and Space Administration
Hugh L. Dryden Flight Research Center, Edwards, Calif

PRACTICAL ASPECTS OF A MAXIMUM LIKELIHOOD ESTIMATION METHOD TO EXTRACT STABILITY AND CONTROL DERIVATIVES FROM FLIGHT DATA

Kenneth W. Iliff and Richard E. Maine Washington Apr 1976 34 p refs
(NASA-TN-D-8209, H-908) Avail NTIS HC \$4 00 CSCL 01C

A maximum likelihood estimation method was applied to flight data and procedures to facilitate the routine analysis of a large amount of flight data were described. Techniques that can be used to obtain stability and control derivatives from aircraft maneuvers that are less than ideal for this purpose are described. The techniques involve detecting and correcting the effects of dependent or nearly dependent variables, structural vibration data drift, inadequate instrumentation, and difficulties with the data acquisition system and the mathematical model. The use of uncertainty levels and multiple maneuver analysis also proved to be useful in improving the quality of the estimated coefficients. The procedures used for editing the data and for overall analysis are also discussed.

Author

N76-23274 Tennessee Univ., Knoxville

AN INTEGRAL EQUATION METHOD FOR BOUNDARY INTERFERENCE IN PERFORATED-WALL WIND TUNNELS AT TRANSONIC SPEEDS Ph.D. Thesis

Edward Michael Kraft 1975 133 p
Avail Univ Microfilms Order No 76-11062

The wind tunnel boundary interference at transonic speeds on thin airfoils in two-dimensional perforated-wall wind tunnels is determined. The interference is found by applying integral equation methods to the nonlinear transonic small disturbance equation including embedded supersonic regions with shock waves. The integral equation method for thin airfoils in free air is also examined. It is found that the introduction of a novel

influence function yields a self-contained integral equation for lifting airfoils. Solutions for nonlifting airfoils in perforated-wall wind tunnels using the integral method indicate that the wind tunnels can have a profound effect on the shock location on the airfoil. It is demonstrated that the correct shock location as compared to free-air solutions can be obtained by the proper selection of porosity. The porosity required for interference-free testing is shown to be dependent on the Mach number and the airfoil configuration.

Dissert Abstr

N76-23290 Air Force Armament Lab., Eglin AFB, Fla
AIRCRAFT/STORES COMPATIBILITY ANALYSIS AND FLIGHT TESTING

Charles S. Epstein In AGARD Range Instrumentation, Weapons Systems Testing and Related Techniques Feb 1976 13 p refs

The state-of-the-art in the field of aircraft/store compatibility testing has been expanded through new photographic, analytic, wind tunnel, and computer techniques. An in-depth explanation of the latest analysis and flight test techniques is given, including the unique marriage of the wind tunnel and the high-speed digital computer in the preflight analysis of data and the photo-imaging technique of flight test data reduction.

Author

N76-23349*# TRW Systems Group, Redondo Beach, Calif
ZERO-G FLIGHT TEST OF A GAUGING SYSTEM VOLUME 1 SUMMARY

Jan 1976 92 p refs
(Contract NAS9-14349)
(NASA-CR-147706 TRW-26960-6001-TU-00-Vol-1) Avail NTIS HC \$5 00 CSCL 14B

The capability of a nucleonic gauging system to gauge the content of a reduced-scale storable liquid tank in a zero-g environment as provided by a KC-135 Zero-G Aircraft was demonstrated. Although the propellant-ullage interface never achieved the stable zero-g equilibrium configuration, the gauging system gauged liquid quantity over all tank loadings to a total system accuracy the order of two percent. It was also determined that the gauging system presented no undue safety hazard to operating personnel in either ground and/or flight testing.

Author

N76-23350*# TRW Systems Group, Redondo Beach, Calif
ZERO-G FLIGHT TEST OF A GAUGING SYSTEM VOLUME 2 SYSTEM SOFTWARE

Jan 1976 83 p
(Contract NAS9-14349)
(NASA-CR-147707 TRW-26960-6001-TU-00-Vol-2) Avail NTIS HC \$5 00 CSCL 14B

The nucleonic gauging system software for the computation of propellant mass is described.

Author

N76-23358*# Acurex Corp., Mountain View, Calif
Aerotherm Div

FOAM COMPOSITE STRUCTURES Final Report

Chadwick B. Delano and Robert J. Milligan Mar 1976 58 p ref
(Contract NAS2-8189)
(NASA-CR-137834 Aerotherm-76-193) Avail NTIS HC \$4 50 CSCL 11D

The need to include fire resistant foams into state of the art aircraft interior paneling to increase passenger safety in aircraft fires was studied. Present efforts were directed toward mechanical and fire testing of panels with foam inclusions. Skinned foam filled honeycomb and PBI structural foams were the two constructions investigated with attention being directed toward weight/performance/cost trade-off. All of the new panels demonstrated improved performance in fire and some were lighter weight but not as strong as the presently used paneling. Continued efforts should result in improved paneling for passenger safety. In particular the simple partial filling (fire side) of state-of-the-art honeycomb with fire resistant foams with little sacrifice in weight would result in panels with increased fire resistance. More

important may be the retarded rate of toxic gas evolution in the fire due to the protection of the honeycomb by the foam
 Author

**N76-23626*# Boeing Commercial Airplane Co Seattle Wash
 ACCELERATION OF FATIGUE TESTS FOR BUILT-UP
 TITANIUM COMPONENTS Final Report**

R T Watanabe Washington NASA May 1976 55 p refs
 (Contract NAS1-12501)
 (NASA-CR-2658 D6-42768) Avail NTIS HC \$4 50 CSCL
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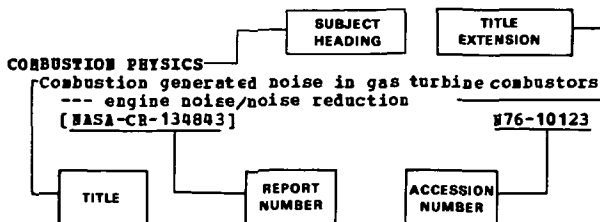
A study was made of the feasibility of a room-temperature scheme of accelerating fatigue tests for Mach 3 advanced supersonic transport aircraft. The test scheme used equivalent room-temperature cycles calculated for supersonic flight conditions. Verification tests were conducted using specimens representing titanium wing lower surface structure. Test-acceleration parameters were developed for the test with an auxiliary test set. Five specimens were tested with a flight-by-flight load and temperature spectrum to simulate typical Mach 3 operation. Two additional sets of five specimens were tested at room temperature to evaluate the test-acceleration scheme. The fatigue behavior of the specimens generally correlated well with the proposed correction method.
 Author

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AUGUST 1976

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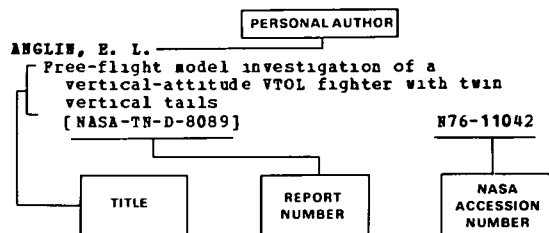
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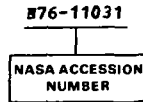
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